Feather River Coordinated Resource Management
Watershed Monitoring Program
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With Plumas Corporation
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Final Report

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EXECUTIVE SUMMARY

This report presents watershed monitoring data from numerous sites in the Feather River watershed collected by members of the Feather River Coordinated Resource Management Group since 1999. The data presented in this report are meant to be baseline data to which future monitoring efforts can be compared, in order to track trends in the watershed, and possibly see if restoration efforts have a significant effect on watershed function. Precipitation varied from 56% to 111% of normal during the monitoring period. Physical stream characteristics, flow regime, water quality and biota were monitored. This report summarizes a copious amount of data, however, these data will prove most useful in the future when they can be referenced for comparisons. The questions we are attempting to answer are long-term questions on a large scale, and we have found it most beneficial for our purposes, at this time, to look at this large landscape scale as a sum of the parts. The sources of the data need to be kept in mind, as well as the fact that these are small sample sites within a large landscape.

The Feather River watershed includes 3,222 square miles of land base that drains west from the Great Basin Escarpment of the northern Sierra Nevada and southern Cascade mountains into the Sacramento River. Annual precipitation ranges less than 12" to more than 70".

The long term objectives of the watershed monitoring program are to:

- Continuously monitor changes in water temperature over time as a key parameter in assessing changes in watershed condition. A significant reduction in summer water temperatures over time is indicative of improving watershed condition.
- Continuously monitor changes in surface water flow over time as a key parameter in assessing changes in watershed condition. A significant increase in summer base flow and reduced peak flow are indicative of improving watershed condition.
- Continuously monitor changes in turbidity over time as a parameter in assessing watershed condition changes. An overall long-term decrease in turbidity is indicative of improving watershed condition.
- Monitor bedload and suspended sediment at various flows to gain a greater understanding of watershed function.
- Monitor physical and biological changes in Monitoring Reaches, as an indicator of upstream conditions:

  Channel morphology, including channel cross sections, channel entrenchment and gradient, channel bed material sampling, large woody debris, (LWD), and pool tail fines. Transect data includes bank stability, shade, width/depth ratio, stream shore water depth, and bank angle. Bankfull will be estimated based on known procedures and field indicators.

  Water chemistry, including water, air temperature and turbidity.

  Habitat, including spatial distribution of fast and slow water via longitudinal gradient (i.e. pool and riffle orientation), pools (size, depth and number), pool tail substrate (% fines), shading, and stream bank stability (i.e. vegetation cover).

  Aquatic fauna, including macroinvertebrates, including analysis of population numbers and species diversity.

  Aerial and ground photographs to provide visual documentation of in-stream and upland changes in vegetation and channel structure, and to support other monitoring results.

There are four main stream systems covered under this monitoring program: Indian and Spanish Creeks (which together make the East Branch North Fork Feather River (EBNFFR)), the North Fork Feather, and the Middle Fork Feather, using two main types of monitoring sites: Monitoring Reaches (MR) and Continuous Recording Stations (CRS).

The most significant findings of the monitoring include:

Geomorphic:

- No sites showed a clear improving or declining trend in geomorphic parameters from 1999 to 2003.

Temperature:

- Indian Cr at Flournoy Bridge and Sulphur Creek showed some increases in temperatures despite higher flows.
- Wolf Cr at Main Street in Greenville generally showed a temperature improvement even with declining flows; some of which could be due to the beaver dam downstream of the site, (which is increasing depth at the sensor) and ever-improving riparian vegetation.
- As far as tributaries into Indian Cr, Lights has a worse temperature condition than Wolf, and both were generally worse than Red Clover @ Drum.
- Spanish Cr was generally in better temperature condition than Indian Cr in 2001 and 2003.
- All but six monitoring sites had temperatures regimes that were not conducive to coldwater fisheries.

Water Quality:

- The Middle Fork Feather River at Beckwourth goes dry in most dry years, and was high in turbidity, total suspended solids, total dissolved solids, alkalinity, EC, and metals.
- Depending on which water quality objective level is used for aluminum, several sites did not meet the objective.
- Lights Creek did not meet Basin Plan objectives for copper.
- Manganese levels were higher than Basin Plan Objectives at numerous sites.
- Rock, Indian above Flournoy, and Spanish above Indian had some of the highest total coliform in both 2001 and 2003.
- Sulphur Creek, Greenhorn Creek, and Lights Creek had some of the highest fecal coliform in both years.
- Turbidity monitoring through American Valley showed a general increase in turbidity from the upstream to the downstream sites.

Aquatic Biota:

- No salmonids were detected at Wolf, Lights, and Last Chance Creeks.
- The general trend of increasing fish biomass from 2001 to 2003 is probably a reflection of the increased flow between those years.
- The general decline in macroinvertebrate indices is probably a reflection of declining flows from 1999 to 2001.
- At Butt Cr, in 2003, suckers appeared.

Flow:

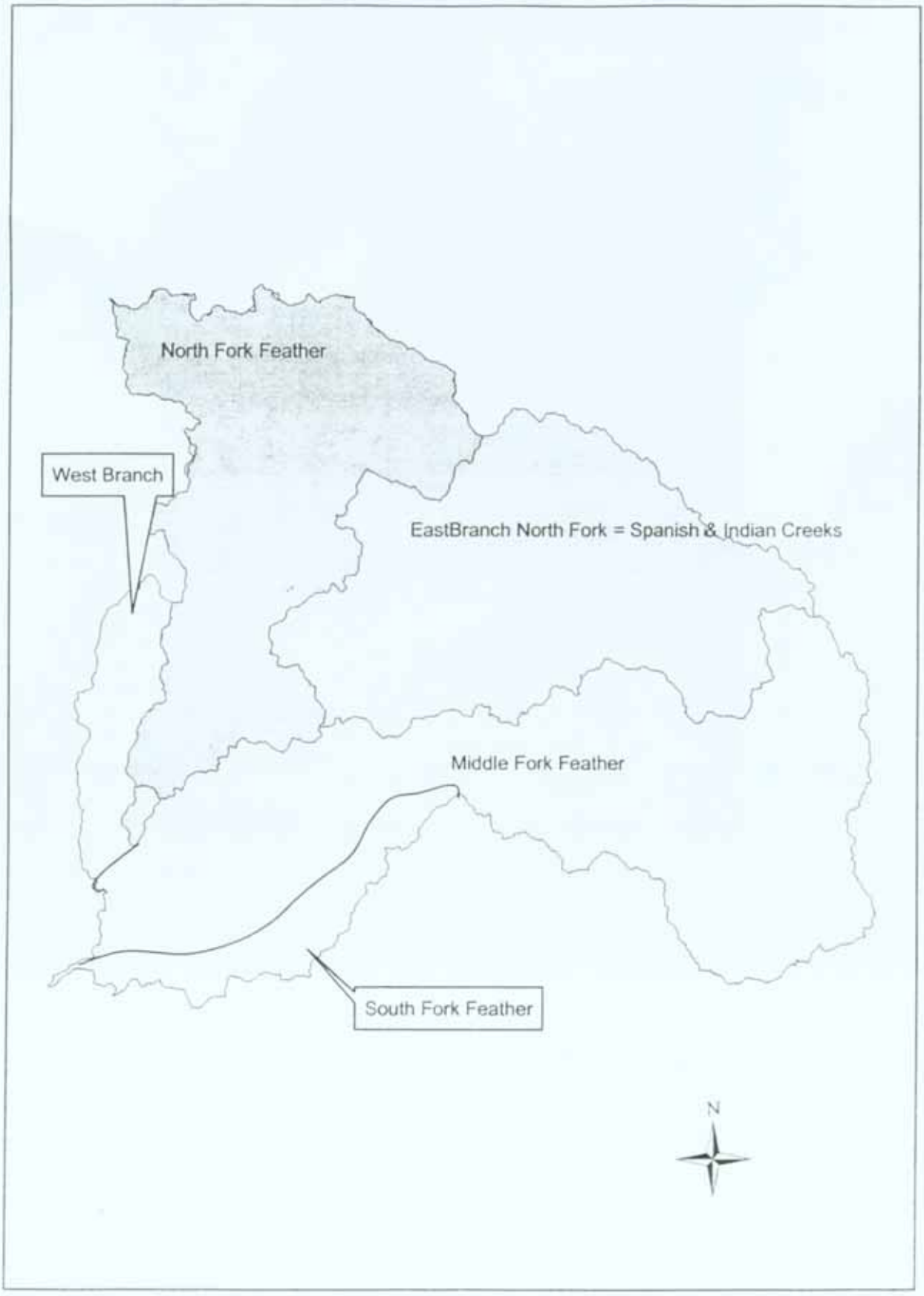
- Despite increasing precipitation from 2001 to 2003, Lights Cr showed a steady decline in the 7-day average minimum flow.

Recommendations for future monitoring include:

- Five year or moderate event monitoring at the alluvial sites.
- Ten year or major event monitoring at the non-alluvial sites.
- Use macroinvertebrate monitoring to trigger further water quality monitoring.
- Continue to maintain and calibrate all Continuous Recording Stations.
- Continue intensive monitoring in watersheds with expected restoration work.

(See Table 14 at the end of the report.)

Figure 1. Major watersheds in the upper Feather.



CHAPTER I

INTRODUCTION

Watershed Overview

The Feather River watershed includes 3,222 square miles of land base that drains west from the Great Basin Escarpment of the northern Sierra Nevada and southern Cascade mountains into the Sacramento River. The Feather River is unique in that the North and Middle Forks bisect the crest of the Sierra. Elevations range from 2,250 to over 10,000 feet. Annual precipitation ranges from less than 12" on the eastside, to more than 70" on the western slopes. Vegetation ranges from sage and eastside pine in the east, to mixed conifer and deciduous forests in the west.

Water produced from the Feather River provides over 4,000 MW of hydroelectric power, and represents a significant component of the State Water Project, annually providing 3.2 million acre-feet for urban, industrial, and agricultural consumers downstream. This monitoring report covers a portion of the upper Feather River watershed: from the North Fork headwater areas down to the confluence of the North Fork Feather with the East Branch North Fork Feather; all of the East Branch North Fork Feather River; and from the Middle Fork headwater areas down to Nelson Point (see Figure 1).

National Forest lands cover a significant part of the upper Feather River watershed. Public, as well as private forestlands, contribute to a timber-based local economy in the upper Feather. Cattle ranching is another important economic activity, and is conducted primarily in active or terraced floodplains on both public and private land. There is also light industry in the area, and roughly 25,000 residents. The upper Feather River watershed also provides habitat to numerous species that are federally Endangered or Threatened, as well as other species of special concern.

The Feather River has been impacted by 140 years of intense human use, including mining, grazing, timber harvesting, railroads and roads. Wildfires have also had an impact on the watershed. Intense use and natural processes have led to a watershed-wide problem of channel entrenchment. Five-hundred square miles of alluvial systems in the headwaters areas are particularly impacted by entrenchment. Functionally, this has led to higher peak winter flows, and lower summer flows, which, in turn affects water quality, aquatic and riparian habitats, productivity of adjacent lands, and downstream beneficial uses.

Monitoring Program Objectives

The long term objectives of the program are to:

- Continuously monitor changes in water temperature over time as a key parameter in assessing changes in watershed condition. A significant reduction in summer water temperatures over time is indicative of improving watershed condition.
- Continuously monitor changes in surface water flow over time as a key parameter in assessing changes in watershed condition. A significant increase in summer base flow and reduced peak flow are indicative of improving watershed condition.
- Continuously monitor changes in turbidity over time as a parameter in assessing watershed condition changes. An overall long-term decrease in turbidity is indicative of improving watershed condition.

- Monitor bedload and suspended sediment at various flows to gain a greater understanding of watershed function.
- Monitor physical and biological changes in reference reaches, as an indicator of upstream conditions:

  Channel morphology, including channel cross sections, channel entrenchment and gradient, channel bed material sampling, large woody debris, (LWD), and pool tail fines. Transect data includes bank stability, shade, width/depth ratio, stream shore water depth, and bank angle. Bankfull will be estimated based on known procedures and field indicators.

  Water chemistry, including water, air temperature and turbidity.

  Habitat, including spatial distribution of fast and slow water via longitudinal gradient (i.e. pool and riffle orientation), pools (size, depth and number), pool tail substrate (% fines), shading, and stream bank stability (i.e. vegetation cover).

  Aquatic fauna, including Macro-invertebrates, including analysis of population numbers and species diversity in comparison to Sierra Nevada reference sites.

  Aerial and ground photographs to provide visual documentation of in-stream and upland changes in vegetation and channel structure, and to support other monitoring results.

The results of this monitoring program are also expected to help the FR-CRM assess the long-term trends in watershed condition in response to natural and management changes, and restoration projects, and provide useful information to help prioritize limited restoration funding to areas of greatest need.

Monitoring Program Description

There are four main stream systems covered under this monitoring program: Indian and Spanish Creeks (which together make the East Branch North Fork Feather River (EBNFFR)), the North Fork Feather, and the Middle Fork Feather. Most of the monitoring effort is concentrated in the Indian Creek watershed because of its highly degraded upper watershed condition, and high potential for restoration with many square miles of alluvial valleys. Site location follows a nested approach.

There are two main types of monitoring sites funded by this grant: Monitoring Reaches (MR) and continuous recording stations (CRS). The following schema and Figure 2 show the locations of these monitoring sites (as well as some others). Photos of each site are in Appendix G. Watershed monitoring in the Feather River watershed, is also conducted by other CRM agencies, which contributes to the CRM's database. Those primary partners are the Plumas and Lassen National Forests, and the Calif. Dept. of Water Resources (DWR).

The monitoring sites are nested within sub-watersheds as follows:

North Fork Feather River watershed

NFFR @ acw East Branch (MR)
- Butt Cr (MR)
- Goodrich Cr (MR) (discontinued)

NFFR @ Domingo Springs (MR)
- East Branch mouth (MR)
  - Spanish mouth (MR)
  - Spanish Cr acw Greenhorn (MR)
    - Greenhorn Cr mouth (MR)
  - Spanish @ Gansner (CRS)
    - Rock Cr mouth (MR)
  - Indian Cr @ Indian Falls
    - Wolf Cr @ Park (MR)
    - Wolf Cr @ Main St Bridge (CRS)

Lights Cr (MR & CRS)
Indian @ T-ville (MR & CRS)
Indian @ Flournoy (MR & CRS)
Indian @ DWR weir (abv Red Clover) (MR & CRS)
Red Clover @ Chase Bridge (MR)
Red Clover Cr @ Drum (MR)
RC @ Notson (CRS)
Last Chance Cr @ Murdock (MR)
LC @ Doyle x-ing (CRS & DWR weather)
McClellan Cr (DWR)
Little Stoney Cr (DWR)
Willow Cr (DWR)
LC @ Alkali Flat low water x-ing (DWR)
Ferris Cr (DWR)
LC @ Bird-Jordan Neck (staff gage & DWR)

Middle Fork Feather River watershed

Nelson Cr (MR)
MFFR @ Sloat (staff gage)
Jamison Cr (MR)
Sulphur Cr @ Clio (MR & CRS)
Boulder Cr (staff gage)
Barry Cr (staff gage)
Sulphur @ Lower Loop Bridge (staff gage)
Sulphur @ Upper Loop Bridge (staff gage)
MFFR @ Beckwourth (MR)

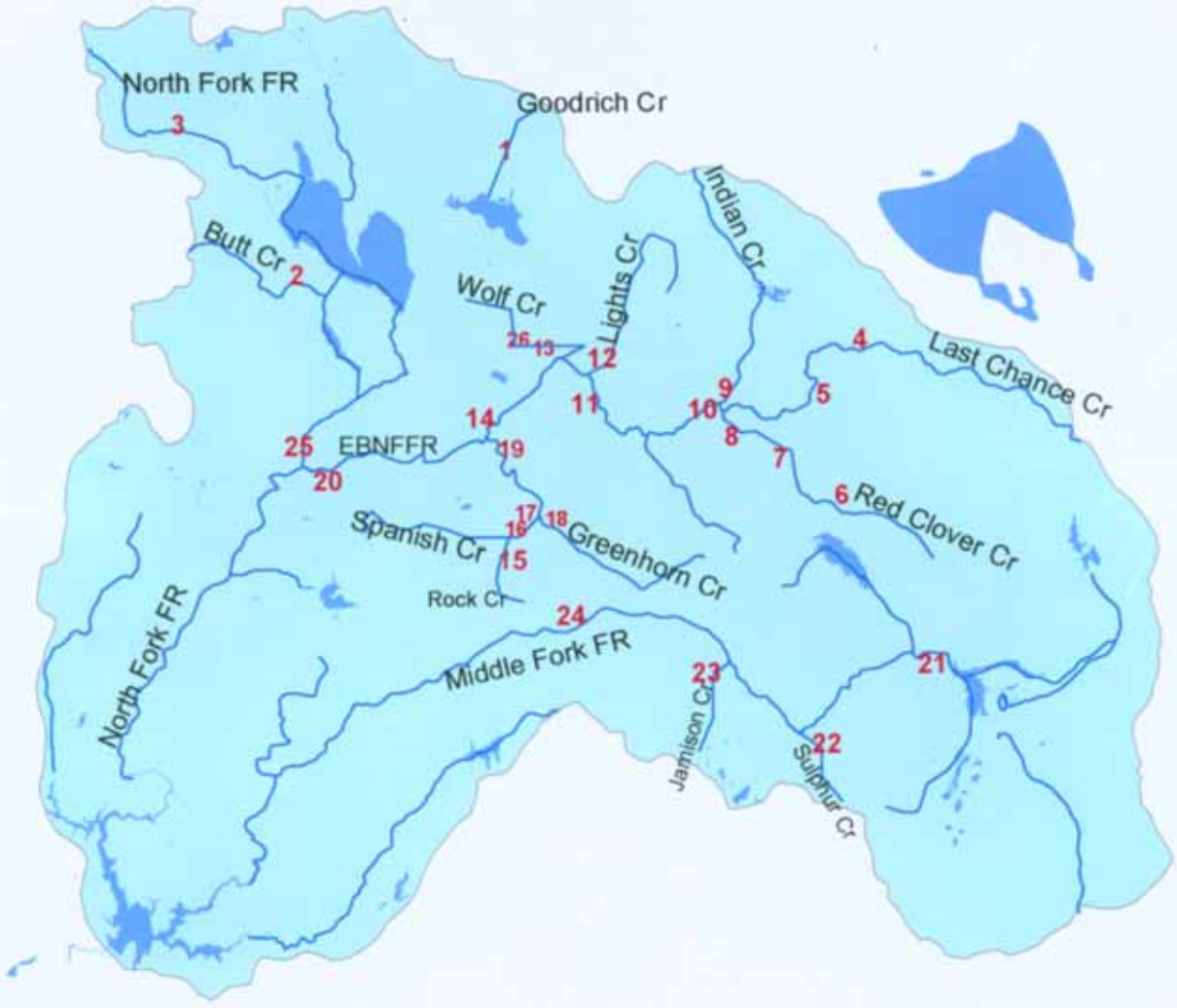
The types of data collected at each location are as follows. Data are presented in the Results and Significant Findings chapter. For a more detailed discussion of the objective and method of each measurement, please refer to the 319(h) final report and QAP in Appendix A.

Monitoring Reaches (MR):
Monitoring Reaches are typically 1000-feet reaches located at the bottom of a subwatershed in a depositional reach. They are based on the USFS Region Five Stream Condition Inventory model (SCI), with some modifications and additions. Measurements that are taken are expected to reflect the condition of the watershed above the Monitoring Reach. Caveats with that assumption are: 1) if there is a lot of disturbance at the monitoring reach location, measurements may be more a reflection of changes in that reach rather than watershed-wide changes; and 2) SCI sites were developed for watersheds of 5,000-10,000 acres, whereas the FR-CRM Monitoring Reach sites encompass larger watershed areas. However, the CRM's philosophy of project design has always been to assess a number of metrics, rather than relying on one single method of analysis. The CRM's monitoring program follows this same philosophy.

The FR-CRM's location of Monitoring Reaches (as well as Continuous Recording Stations) is complementary to the Plumas and Lassen National Forest SCI monitoring locations, and are typically on private lands that are not accessible to the Forest Service. A true assessment of any of these watersheds based on Monitoring Reach data should look at upstream Forest Service SCI sites, as well as the CRM sites. Monitoring Reach surveying has been conducted on a biennial basis, and, with a one-year grant extension, was conducted twice under this grant. It should also be noted that care is taken to conduct the survey at each site within approximately the same two weeks each year. It should also be noted that all of the CRM sites are monitored within the same year. This differs from the Forest Service approach of staggering site monitoring, so that a few are monitored each year, so that each site is monitored once every five years. The CRM approach of all sites within the same year allows for a more valid comparison between sites.

Figure 2.

Upper Feather River Watershed Monitoring Locations



1. Goodrich Cr
2. Butt Cr
3. NFFR abv Lake Almanor
4. Last Chance Cr @ Doyle Crossing (CRS)
5. Last Chance Cr blw Murdock Crossing
6. Red Clover Cr blw Chase Bridge
7. Red Clover Cr at Notson Bridge (CRS)
8. Red Clover Cr blw Drum Bridge
9. Indian Cr abv Red Clover (DWR weir)
10. Indian Cr blw Red Clover (Flournoy)
11. Indian Cr at Taylorsville
12. Lights Cr
13. Wolf Cr near Town Park
14. Indian Cr abv Spanish Cr
15. Rock Cr
16. Spanish Cr at Hwy 70 (Gansner Park)
17. Spanish Cr abv Greenhorn
18. Greenhorn Cr
19. Spanish Cr abv Indian
20. East Branch North Fork Feather abv NFFR
21. Middle Fork Feather @ Beckwourth
22. Sulphur Cr
23. Jamison Cr
24. Middle Fork Feather abv Nelson Cr
25. North Fork Feather
26. Wolf Cr @ Main St Bridge

CHAPTER II

RESULTS AND SIGNIFICANT FINDINGS

The data presented in this report are considered as baseline data to which continued monitoring can be compared in order to determine trends in watershed function and whether or not the CRM's restoration efforts are making significant measurable improvements on a watershed scale. The reader and any users of these data are cautioned against using any one year of data out of context. Table 1 shows the precipitation range over which these data were collected.

Table 1. Precipitation averages

Water Year (10/1-9/30)	Percent of Historic Average annual precip for all Feather River Basin from CDEC	Water Year (7/1-6/30)	Total annual precip (inches) near Indian Cr in Genesee (Wilcox data)
		1996	54.55
		1997	58.9
1998	144%	1998	60.70
1999	99%	1999	47.8
2000	101%	2000	43.65
2001	56%	2001	23.6
2002	77%	2002	33.6
2003	111%	2003	49.6
			46.55 = Avg

Geomorphology and Habitat

Table 2 displays annual summary data for selected geomorphic and habitat parameters at 19 Monitoring Reaches. The full summary data are displayed for each monitoring site in Appendix B. Raw data are available at the Plumas Corporation Office. Plotted permanent cross-sections are displayed in Appendix C. Plotted pebble counts are in Appendix D. Plotted channel profiles are in Appendix E.

Table 2. Summary of Geomorphic and Habitat Parameters at all Monitoring Reaches

Map #	Location	Year	average BF width (ft)	average BF depth (ft)	Average W/D	Average entrench-ment	Average percent fines	Pool:riffle ratio	Pebble count D_{50} (mm)
	Alluvial Channels								
1	Goodrich	1999	24.5	1.2	21	19.7	16%	2	
		2001	20.5	0.9	22	25.7	3	3.5	
2	Butt (CRM)	1999	38.3	1.9	21	1.9	14	1.3	
		2001	47.7	1.9	21	3.1	10	1.4	29.5
		2003	52.8	2.2	24	3.2	12	0.9	27
13	Wolf	1999	25.7	1.5	17	2	64	1.1	
		2001	31.7	1.5	22	2.7	22	1.8	15.5
		2003	24.1	1.4	18	2.3	26	1.7	18.5
12	Lights	1999	48.1	1.8	27	1.2	63	2.1	
		2001	32.8	1.5	24	2	15	7.2	18
		2003	33.4	1.3	27	2.1	38	4.7	16.5
5	Last Chance	1999	37.4	1.4	26	1.9	55	4.2	
		2001	36.6	1.3	30	2	18	7.3	18
		2003	32.7	1.4	24	2.5	25	9	21
10	Indian blw Red Clover	1999	78	1.8	48	1.7	37	1.7	
	(abv Flournoy Bridge)	2001	83.5	2	43	2.7	6	1.8	30
		2003	79.7	2	40	2.2	23	1.6	27
11	Indian blw Tville Bridge	1999	102.4	1.9	53	2.5	35	3.8	
		2001	102.4	1.6	64	4.3	2	3.6	35
		2003	121.4	2.2	55	2.9	12	4.9	36
18	Greenhorn	1999	36.9	1.6	24	1.5	31	1.3	
		2001	38.4	1.4	30	1.4	33	2.3	17.5
		2003	39.2	1.4	30	1.4	6	3.1	22
17	Spanish abv Greenhorn	1999	57.8	1.7	34	1.6	20	1.9	
		2001	70.8	2.2	32	1.5	17	3.6	11
		2003	75.8	2.3	33	1.4	14	3.2	16.5
21	MF Feather @ Beckwourth	1999	34.8	1.3	27	2.6	82	11.5	
		2001	43.5	1.4	31	2.5	35	13.7	5
		2003	49.1	1.6	30	2.3	58.3	8.8	15
22	Sulphur	1999	43.9	1.3	35	2.2	40	1	
		2001	39.2	1.2	34	2.8	10	0.9	30
		2003	42.9	1.3	33	3.1	19	1.1	40
6	Red Clover@Chase Bridge	1995	52	1.4	37	1.9	20	1.1	15
		2003	65	1.7	40	1.6	40	1.8	22
	Depositional/ non-alluvial Channels								
15	Rock	1999	45.8	1.5	31	1.3	24	0.6	
		2001	50.5	2	27	1.6	5	0.6	33
		2003	51.1	2.2	24	1.7	10	0.6	38
19	Spanish abv Indian	1999	75.5	2.2	35	1.5	37	2.7	
		2001	94.2	2.6	38	1.5	10	2.7	29
		2003	88.7	2.9	30	1.5	12	2.6	28.5
	Non-alluvial channels								
3	NF Feather abv Almanor	1999	53.1	2.1	26	2.3	16	0.5	
		2001	55.5	1.9	30	2.2	14	0.9	
		2003	63.7	2.5	27	2	16	0.6	
25	NF Feather abv	1999	63.8	1.2	56	1.3	9	0.2	
	East Branch	2001	63.4	1.3	51	1.2	3	0.8	55
		2003	66.7	1.2	56	1.2	no data	0.1	30
20	East Branch NF Feather	1999	119.4	2.8	46	1.6	10	2.4	
		2001	122.3	2.6	48	1.7	12	1.9	102
		2003	133	3.3	41	1.6	12	2.1	74
8	Red Clover @ Drum	1999	53.2	2.1	26	2.1	9	0.4	
		2001	60.6	2.2	29	2.4	4	0.2	
14	Indian abv Spanish	1999	112.3	2.2	55	1.4	13	2.1	
		2001	109.2	2.4	46	1.5	7	1.1	102
		2003	115	2.2	52	1.5	21	1.7	104
23	Jamison	1999	39.9	1.7	24	1.4	8	0.2	
		2001	40.9	1.7	25	1.2	3	0.2	34
		2003	41.6	1.5	28	1.2	11	0.2	32
24	MF Feather abv Nelson	1999	92.8	2.3	42	1.6	15	1.2	
		2001	83.7	2.1	46	1.5	9	1.1	93
		2003	92.3	2.5	38	1.6	7	1.2	74

Notes:
Avg BF width, BF depth, W:D, and Entrenchment calculated by averaging 3 permanent cross-sections and 5 random transects.
More detailed description of parameters in Appendices A & B.

While the three years of data presented in Table 2 are considered as baseline data, an attempt was made to see if there was significant change at any location. Change was arbitrarily considered to be a 20% difference from one year to the next, or a steady trend in one direction for all three years.

No sites showed a clear improving or declining trend from 1999 to 2003. This is not surprising, considering the lack of major bedload moving events during this period. However, there were more changes in parameters at the alluvial sites than the non-alluvial sites. This is also to be expected since SCI is recommended for alluvial sites.

Width to depth ratio remained the same at all but six sites between the three years. The sites that exhibited change did not show a clear trend, except Greenhorn Cr, which showed a nearly steady increase in width to depth ratio (a declining trend).

Entrenchment decreased (shown by an *increase* in the entrenchment ratio number) at every site where there was a change between 1999 and 2001. Entrenchment increased only at two sites (Indian blw Red Clover and blw Tville Bridge) between 2001 and 2003.

Percent fines decreased at every site where there was a change between 1999 and 2001, and mostly increased from 2001 to 2003.

Pool to riffle ratios showed changes at most sites. Most changes were ambiguous, except for a steady increase in pools at Last Chance and Greenhorn Creeks. An important point to note, however, is that pools were defined differently by the survey crew in 1999 than the other years. Erroneously, 1999 was based more on the observer's definition of what a pool looks like. Following the protocol in 2001 and 2003, pools were defined as a section of channel where the max depth is twice as deep as the pooltail crest depth. The change in definition accounts for the increase in pool numbers at some sites.

Pebble counts between 2001 and 2003 were analyzed in greater detail than the other parameters in Table 2. A full discussion of that analysis, including particle size distribution graphs, is presented in Appendix D. To summarize the discussion, most reaches showed an improving trend, as would be expected with the increased flow, and three showed a declining trend: Greenhorn, NFFR abv Almanor, and NFFR abv EBNFFR. Full bedload pavement and subpavement samples were collected in 1999. Those samples are currently being analyzed by DWR.

Permanent Cross-sections

Six of the permanent cross-sections were analyzed in greater detail, and there were no discernable changes in the six analyzed cross-sections. That full analysis is in Appendix C. The full analysis included a calculation of cross-sectional area, which is not included in Table 2. Some of the variability found in the data is presumed to be due more to subjective field bankfull determinations than actual channel changes.

Channel Profile

Appendix E displays three years of channel profiles for each Monitoring Reach. As expected, with relatively normal to low flows in this reporting period, there was not significant change in channel profile at any site. Max pool depths are included on some of the graphs. Although a change in pool depth (as so many indicators of change) would have to be looked at in context of other parameters, pool infilling could indicate a new upstream source of sediment. Pool deepening could indicate a degradation cycle. Again, it should be remembered that pools were defined differently by the survey crew in 1999 than the other years (which accounts for some of the increase in pool numbers at some sites). Also, some water surface elevation points were obviously in error

(showing water flowing uphill). Without being able to go back and re-survey at this juncture, points that appeared erroneous were simply edited out. All of the raw survey data are available at the Plumas Corporation office.

Water Quality

Tables 3a-8 display temperature and other water quality data. Table 9 displays water quality objectives and criteria for comparison. A discussion of each table follows.

Water Temperature

Table 3a and 3b display summer water temperature data, collected at the Monitoring Reaches (every other year with Hobotemp dataloggers) and Continuous Recording Stations (continuously with Campbell CR10X data loggers). Table 3a is listed by station. Table 3b displays the same data, listed by year.

Definitions of headings in Tables 3a and 3b:
Absolute daily MAX water temp = The highest 1 hour-long temperature that was recorded during the sampling period
MAX 7-day avg of daily avg = A running 7-day average was calculated throughout the sampling period. This column displays the highest of those seven-day averages.
 # 7-day averages >66F = This column displays the number of running seven day averages that were greater than 66 degrees Farenheit. The importance of this parameter is biological, in that if the water is an average temperature greater than 66F for seven days, it is probably not conducive to a coldwater fishery.
 # days with max >75F = This column displays the number of days that had an absolute 1-hour long temperature greater than 75F. The importance of this parameter is also biological, in that if the water is even has a short-term maximum greater than 75 degrees Farenheit, then it is probably not conducive to a coldwater fishery.
Max summer diurnal fluctuation = This column shows the greatest fluctuation in temperature in a 24-hour period during the sampling period.
Data days – This column shows the dates of the sampling period, and is important to note in comparisons between years. Unfortunately, some stations in 2003 have incomplete data.

Table 3a. Summer water temperatures for all sites (CRS & MR) Listed by Site

Map #	station	year	Absolute Max daily Max water temp	Max 7-day avg of daily avg	# 7-day averages >66F	# days with max >75F	Max summer diurnal fluctuation F	data days
3	NF Feather abv Almanor	2001	64	55	0	0	12	6/14-9/10
		2003*	59*	53*	0*	0*	14*	6/15/-8/15
1	Goodrich	2001	73	69	25	0	12	6/14-9/10
2	Butt (CRM)	2001	71	61	0	0	19	6/14-9/10
		2003	71	61	0	0	17	6/15-9/7
25	F Feather abv East Branc	2003	69	58	0	0	8	6/10-9/6
4	Last Chance @Doyle Crossing	2000	85	73	57	71	58	continuous
		2001	88	73	67	102	63	continuous
		2002	89	73	54	88	60	continuous
		2003	90	74	56	85	61	continuous
5	Last Chance@SCI	2001	82	72	64	59	22	6/8-9/2
		2003*	80*	72*	28*	26*	20*	6/14-7/31
7	Red Clover @ Notson	2000	79	67	6	18	53	continuous
		2001	79	68	22	40	55	continuous
		2002	80	70	46	47	54	continuous
		2003	81	71	23	28	53	continuous
8	Red Clover @ Drum	2001	87	63	0	0	33	6/8-9/4
		2003	70	66	0	0	10	6/13-8/14
9	Indian abv Red Clover (DWR weir)	2000	68	63	0	0	41	continuous
		2001	74	67	5	0	45	continuous
		2002	69	64	0	0	40	continuous
		2003	71	66	0	0	41	continuous
10	Indian blw Red Clover (@ Flournoy)	2000	73	66	0	0	45	continuous
		2001	79	69	41	27	50	continuous
		2002	69	64	0	0	40	continuous
		2003	78	69	13	3	45	continuous
12	Lights	2000	84	75	79	62	51	continuous
		2001	87	75	110	103	57	continuous
		2002	88	78	97	96	56	continuous
		2003	88	80	80	65	50	continuous
13	Wolf @SCI	2001	79	70	65	28	19	6/4-9/4
26	Wolf @ Main	2000	84	70	43	69	59	continuous
		2001	78	69	53	19	47	continuous
		2002	70	66	0	0	40	continuous
		2003	72	69	13	0	38	continuous
14	Indian abv Spanish	2001	80	73	78	40	13	6/9-9/5
		2003*	80*	74*	22*	13*	10*	/10-6/29; 7/17-9/6
15	Rock	2001	77	69	30	6	15	6/9-9/5
		2003	75	68	14	1	15	6/7-9/3
18	Greenhorn mouth	2001	77	72	61	2	10	6/12-9/6
		2003	76	71	20	4	17	6/16-9/6
16	Spanish @ Gansner	2003	80	71	20	14	49	continuous
17	Spanish abv Greenhorn	2001	77	68	12	12	19	6/12-9/6
		2003*	70*	62*	0*	0*	16*	6/10-7/15
19	Spanish abv Indian	2001	77	73	78	19	11	6/9-9/3
		2003*	78*	71*	16*	5*	10*	/10-6/30; 7/17-9/6
20	East Branch NF Feather	2001	78	74	83	24	8	6/10-9/6
		2003*	81*	74*	27*	13*	11*	6/10-7/31
21	NF Feather @ Beckwourt	2003*	81*	73*	51*	32*	22*	6/7-6/30: 7/17-9/3
22	Sulphur	2001	80	67	18	32	26	6/7-9/3
		2003	83	69	16	38	28	6/7-9/3
23	Jamison	2001	72	63	0	0	17	6/7-9/3
		2003	71	63	0	0	12	6/7-9/3
24	MF Feather abv Nelson	2001	77	73	78	10	9	6/7-9/3
		2003*	66*	60*	0*	0*	8*	6/7-6/25

*Note data days; comparisons between years would not be valid due to incomplete data.

Table 3b. Summer water temperatures for all sites (CRS & MR) Listed by Year

Fig2 Map #	station	year	Absolute daily Max water temp	MAX 7-day avg of daily avg	# 7-day averages >66F	# days with max greater than 75F	Max summer (Jul-Sep) diurnal fluctuation	data days
4	Last Chance @Doyle	2000	85	73	57	71	58	continuous
9	Indian abv Red Clover	2000	68	63	0	0	41	continuous
10	Indian @Flournoy	2000	73	66	0	0	45	continuous
7	Red Clover @ Notsor	2000	79	67	6	18	53	continuous
12	Lights	2000	84	75	79	62	51	continuous
26	Wolf @ Main	2000	84	70	43	69	59	continuous
3	F Feather abv Alman	2001	64	55	0	0	12	6/14-9/10
2	Butt (CRM)	2001	71	61	0	0	19	6/14-9/10
1	Goodrich	2001	73	69	25	0	12	6/14-9/10
4	Last Chance @Doyle	2001	88	73	67	102	63	continuous
5	Last Chance@SCI	2001	82	72	64	59	22	6/8-9/2
7	Red Clover @ Notsor	2001	79	68	22	40	55	continuous
8	Red Clover @ Drum	2001	87	63	0	0	33	6/8-9/4
9	Indian abv Red Clover	2001	74	67	5	0	45	continuous
10	Indian @Flournoy	2001	79	69	41	27	50	continuous
12	Lights	2001	87	75	110	103	57	continuous
26	Wolf @ Main	2001	78	69	53	19	47	continuous
13	Wolf @Mon Reach	2001	79	70	65	28	19	6/4-9/4
14	Indian abv Spanish	2001	80	73	78	40	13	6/9-9/5
15	Rock	2001	77	69	30	6	15	6/9-9/5
18	Greenhorn mouth	2001	77	72	61	2	10	6/12-9/6
17	panish abv Greenhor	2001	77	68	12	12	19	6/12-9/6
19	Spanish abv Indian	2001	77	73	78	19	11	6/9-9/3
20	ast Branch NF Feath	2001	78	74	83	24	8	6/10-9/6
22	Sulphur	2001	80	67	18	32	26	6/7-9/3
23	Jamison	2001	72	63	0	0	17	6/7-9/3
24	MF Feather abv Nelso	2001	77	73	78	10	9	6/7-9/3
4	Last Chance @Doyle	2002	89	73	54	88	60	continuous
7	Red Clover @ Notsor	2002	80	70	46	47	54	continuous
9	Indian abv Red Clover	2002	69	64	0	0	40	continuous
10	Indian @Flournoy	2002	69	64	0	0	40	continuous
12	Lights	2002	88	78	97	96	56	continuous
26	Wolf @ Main	2002	70	66	0	0	40	continuous
3	F Feather abv Alman	2003*	59*	53*	0*	0*	14*	6/15/-8/15
2	Butt (CRM)	2003	71	61	0	0	17	6/15-9/7
25	Feather abv East Bra	2003	69	58	0	0	8	6/10-9/6
4	Last Chance @Doyle	2003	90	74	56	85	61	continuous
5	Last Chance@SCI	2003*	80*	72*	28*	26*	20*	6/14-7/31
7	Red Clover @ Notsor	2003	81	71	23	28	53	continuous
8	Red Clover @ Drum	2003	70	66	0	0	10	6/13-8/14
9	Indian abv Red Clover	2003	71	66	0	0	41	continuous
10	Indian @Flournoy	2003	78	69	13	3	45	continuous
12	Lights	2003	88	80	80	65	50	continuous
26	Wolf @ Main	2003	72	69	13	0	38	continuous
14	Indian abv Spanish	2003*	80*	74*	22*	13*	10*	10-6/29; 7/17-9/6
15	Rock	2003	75	68	14	1	15	6/7-9/3
18	Greenhorn mouth	2003	76	71	20	4	17	6/16-9/6
16	Spanish @ Gansner	2003	80	71	20	14	49	continuous
17	panish abv Greenhor	2003*	70*	62*	0*	0*	16*	6/10-7/15
19	Spanish abv Indian	2003*	78*	71*	16*	5*	10*	10-6/30; 7/17-9/6
20	ast Branch NF Feath	2003*	81*	74*	27*	13*	11*	6/10-7/31
21	F Feather @ Beckwou	2003*	81*	73*	51*	32*	22*	/7-6/30; 7/17-9/3
22	Sulphur	2003	83	69	16	38	28	6/7-9/3
23	Jamison	2003	71	63	0	0	12	6/7-9/3
24	MF Feather abv Nelso	2003*	66*	60*	0*	0*	8*	6/7-6/25

*Note data days. Comparisons between years would not be valid due to incomplete data.

When analyzing water temperature data, it is important to keep in mind the precipitation (Table 1), streamflow (Tables 13a&b) and air temperature conditions for the year. (Between the summers of 2001, 2002 and 2003, air temperatures were highest in 2001.) Based on these conditions, between 2001 and 2003, one would expect to see improvement trends in water temperatures. Most of the sample locations display this trend, or an ambiguous combination of trends in the different parameters. In analyzing the data, improvements or degradation of temperature conditions that counter the precip, flow, and air temp, are most noteworthy:

- Indian Cr at Flournoy Bridge primarily followed the flow trends, except from 2002 to 2003, which showed an increase in temperatures despite the higher flows. (However, this station needs to be checked for accuracy.)
- Sulphur Cr (from 2001 to 2003) showed an increase in temperatures despite higher flows.
- Wolf Cr at Main Street in Greenville generally showed a temperature improvement even with declining flows; some of which could be due to the beaver dam downstream of the site, (which is increasing depth at the sensor) and ever-improving riparian vegetation.

Red Clover at Notson showed a steady increase in max daily and 7-day avg temperatures from 2000-03, with ambiguous changes in the other parameters. Last Chance at Doyle showed a steady increase in daily max temps, but ambiguous changes in the other parameters. The ambiguous results in many parameters made it difficult to rank the different stations by temperature impairment.

Another interesting way to look at the temperature data is to follow temperatures down a watercourse in any particular year. The same data from Table 3a is displayed in Table 3b by year, again roughly organized by watershed. The most noteworthy trends are:

- As far as tributaries into Indian Cr, Lights has a worse temperature condition than Wolf, and both were generally worse than Red Clover @ Drum.
- Spanish Cr was generally in better temperature condition than Indian Cr in 2001 and 2003.
- Because of many differing beneficial uses, no hard and fast water temperature objectives have been set for the Feather River. However, if one were to set objectives of a seven-day average no greater than 66F, and an absolute max no greater than 75F, (both of which are conducive to trout production) then most monitoring sites do not meet these objectives. The six sites that do, or nearly, meet these objectives are: NFFR abv Lake Almanor, Butt Cr, NFFR abv the East Branch, Red Clover @ Drum, Indian abv Red Clover, and Jamison Creek. Wolf at Main and Indian at Flournoy sometimes do, and sometimes do not, meet them.

Other trends include:

- Wolf Creek showed a slight warming of water from the Main Street Bridge site to the Monitoring Reach in 2001, a distance of approximately one mile, most of which was a CRM project area in 1989. The restoration work (as well as a drought) has helped vegetation become established in this stretch of Wolf Cr.
- Indian Cr above Red Clover (@ DWR weir) to Flournoy Bridge (less than one mile), increased in temperature every year except 2002, when both sites were approx. equal. Although, surprisingly, temperatures in Red Clover at Drum in 2001 and 2003 do not appear to be a significant source of this warming.
- As expected in this narrow canyon reach, Red Clover Cr cooled between Notson Br and Drum Br in 2001 and 2003 (except for daily max in 2001).
- Last Chance Creek cooled from Doyle Crossing to Murdock crossing in 2001, which was the only year of valid data.
- Spanish Cr improved in temperature conditions from Gansner Park to the mouth in 2003, but, surprisingly, generally warmed between Spanish abv Greenhorn and the mouth of Spanish in 2001.

Unfortunately, due to lost data, etc., a similar comparison is not possible for the confluence of the East Branch and the North Fork.

Due to bridge modifications, and subsequent installation changes, Indian Cr at Taylorsville has been out of the water in the summer months. We plan to modify this station as soon as funds are available. Also, much of the 2003 temperature data is incomplete due to prolonged spring run-off, and a rapid drop in stage in mid-summer, when some Hobotemps were re-positioned; unfortunately, many were not.

Table 4. Upper Feather River Water Quality Data

Fig2 Map #	Station Name	Date	Time pst	Temp C	Temp. F	D.O. ppm	pH field	EC(field) (umhos/cm)	EC (lab) (umhos/cm)	Alkalinity RBLab (mg/L)	Turbidity RBLab NTU	TSS mg/L	TDS mg/L
3	NF Feather ab Lake Almanor	6/19/01	1330	18.5	65.3	8.8	7.8	70	73	38	0.4	<1.0	72
	NF Feather ab Lake Almanor	8/6/01	1450	20	68	8	7.4	78	83	46	3.8		
	NF Feather ab Lake Almanor	9/10/03	640	9.2	48.6	9.8	7.5	72	74		0.7		
1	Goodrich C	6/21/01	1225	26.1	78.98	7.6	8.3	119	121	67	3.5	4	81
2	Butt C	6/19/01	1420	20.1	68.18	8.4	8.1	127	129	70	0.5	<1.0	90
	Butt C	8/9/01	1100	12.5	54.5	8.1	8.3	160	112	68	0.6		
	Butt C	9/10/03	740	9.7	49.5	9.1	7.3	125	125		1.4		
25	NF Feather R ab EBNFFR	6/20/01	1420	20.6	69.08	8.4	8.3	133	136	69	0.9	2	79
	NF Feather R ab EBNFFR	9/11/03	645	16.0	60.8	8.7	7.9	136	137		0.5		
5	Last Chance @ Murdock	6/21/01	720	16.3	61.34	5.8	8	227	170	88	5.4	14	100
	Last Chance @ Murdock	8/8/01	1100	25	77	8.7	8.3	154	138	81	13		
	Last Chance @ Murdock	9/10/03	1050	14.1	57.4	8.1	8.1	163	160		1.2		
8	Red Clover abv Indian	6/21/01	825	15	59	8.9	8.2	163	185	94	0.5	2	117
	Red Clover abv Indian	8/13/01	1200	21.4	70.52	8.1	8.8	171	150	88	1.2		
	Red Clover abv Indian	9/10/03	1200	12.1	53.8	9.3	8.3	178	177		2.2		
10	Indian C @ Flournoy Br	6/21/01	900	18.1	64.58	8.5	7.4	163	165	82	1.3	1	102
	Indian C @ Flournoy Br	9/24/01	1100	17	62.6	9.5	7.8	174	173	87	1.1		
	Indian C @ Flournoy Br	9/10/03	1230	13.5	56.3	9.6	7.9	128	128		2.2		
11	Indian C @ Taylorsville	6/21/01	940	21.1	69.98	7.9	7.4	150	152	73	1	4	92
	Indian C @ Taylorsville	8/14/01	800	22.4	72.32	7.3	7.3	150	139	75	0.8		
	Indian C @ Taylorsville	9/10/03	1300	17.1	62.8	8.7	7.3	143	140		0.9		
12	Lights	6/19/01	1550	26.9	80.42	7.7	8	161	163	82	4	13	106
	Lights	8/9/01	1500	32.9	91.22	8.5	8.8	255	229	126	24		
	Lights	9/10/03	920	16.1	61.0	7.9	7.9	158	156		2.1		
13	Wolf C MR	6/19/01	1500	25.9	78.62	7.9	8.1	158	161	76	1.2	1	82
	Wolf C MR	8/8/01	1600	27.7	81.86	7.8	8.1	162	145	84	1.9		
	Wolf C MR	9/10/03	835	14.3	57.7	8.1	7.9	145	144		1.5		
14	Indian C ab Spanish C	6/21/01	1010	22	71.6	8.3	8	239	241	108	1.9	3	140
	Indian C AB Spanish C	9/10/03	1330	16.5	61.7	9.1	8.1	215	212		2.1		
15	Rock C	6/20/01	1115	18.1	64.58	9.3	8.3	116	119	61	0.3	<1.0	75
	Rock C	8/10/01	730	17.5	63.5	8.7	8	150	132	70	0.7		
	Rock C	9/9/03	1315	15.8	60.4	10.1	8.3	118	117		0.8		
18	Greenhorn C A Mouth	6/20/01	1200	21	69.8	8.4	7.6	188	189	90	1.5	4	123
	Greenhorn C A Mouth	8/7/01	1400	21.8	71.24	7.3	7.5	190	168	98	1.7		
	Greenhorn C A Mouth	9/9/03	1210	18.4	65.1	8.3	7.3	181	178	in	1.4		
17	Spanish C ab Greenhorn C	6/20/01	1220	20.4	68.72	8.7	7.3	149	150	68	1.4	3	98
	Spanish C ab Greenhorn C	8/8/01	700	16	60.8	6.3	6.8	156	141	77	2		
	Spanish C AB Greenhorn C	9/9/03	1245	17.3	63.1	8.2	7.3	154	143		2		
19	Spanish C ab Indian C	6/20/01	1330	23.5	74.3	8.7	8.3	171	172	84	0.9	<1.0	108
	Spanish C AB Indian C	9/11/03	800	14.8	58.6	8.7	8.1	176	175		0.9		
20	EBNF Feather ab NFFR	6/20/01	1450	23.7	74.66	8.4	8.3	237	238	107	0.8	2	134
	EBNF Feather ab NFFR	9/11/03	715	16.3	61.3	9.2	8.1	242	238		0.5		
21	MF Feather R @ Beckwourth	6/20/01	700	13.1	55.58	5.5	8	271	271	126	26	22	192
22	Sulphur C A Clio	6/20/01	740	12.5	54.5	9	7.8	179	182	91	2	5	118
	Sulphur C A Clio	8/7/01	800	14.7	58.46	8.5	7.6	201	178	100	2.5		
	Sulphur C A Clio	9/9/03	845	12.0	53.6	10.4	8.1	175	172	no	1.1		
23	Jamison C nr Two Rivers	6/20/01	810	12.3	54.14	9.2	7.8	112	115	58	0.3	<1.0	66
	Jamison C nr Two Rivers	8/7/01	1000	19.8	67.64	7.6	7.9	128	115	71	0.2		
	Jamison C nr Two Rivers	9/9/03	940	14.2	57.6	8.8	8.1	130	130		0.5		
24	MF Feather R ab Nelson C	6/20/01	910	20.4	68.72	8	8.1	140	142	70	1.1	<1.0	97
	MF Feather R ab Nelson C	9/9/03	1120	16.8	62.2	8.4	8.1	152	151		1.3		

Contextual Water Quality Parameters

Table 4 displays water quality data collected at each site twice in 2001and once in 2003. Between years, the timing of the sampling is a factor to consider. The data displayed in Table 4 is primarily contextual information in which to put the other water quality parameters. However turbidity, total suspended solids (TSS), and total dissolved solids (TDS) can tell us something between the sites, especially knowing that the samples were collected all within a relatively short time frame (TDS and TSS were only collected in June 2001). The Middle Fork Feather River at Beckwourth was the highest of all three of these parameters (as well as alkalinity and EC). This site has also gone dry later in the year for both sampling years, as it does in most dry years. Temperature, pH and DO cannot be compared due to the diurnal fluctuation of these parameters, and the different times of day at which they were collected. However, pH was within expected levels at all sites, while DO was low only at the Middle Fork at Beckwourth site.

Nutrients

Table 5 displays nutrient data. A comparison between years is mostly invalid due to several factors: 1) the different time of year the samples were collected; 2) the detection levels were different between years (detection levels were not reported with the 2001 data); and 3) nitrates and nitrites were analyzed together in 2001, and separately in 2003. One reason for the detection level difference was budgetary. A DWR contract lab analyzed the samples in 2001, at no cost to the SWAMP contract. However, the SWAMP contract covered the cost of analysis in 2003.

One would expect the 2003 nutrient levels to be higher since the samples were collected in September. However, 2003 was also a higher flow year, and the detection levels were higher. Nitrates and nitrites were not detected at any site in 2003. Total ammonia was not detected at any site in 2003, and only at Lights, Sulphur and MFFR at Beckwourth in 2001. The detection levels were the same for this analysis, showing a decrease in NH_3 from 2001 to 2003 at Lights and Sulphur, probably due to the higher flow year. Beckwourth was not sampled in 2003 due to a lack of continuous flow. Dissolved orthophosphate and total phosphorus decreased or remained the same, or was undetected at every site, except two. Dissolved orthophosphate increased on Indian Cr above Flournoy Bridge, near the mouth above Spanish Cr, and on Last Chance and Red Clover Creeks, and total phosphorus increased on Indian above Spanish. The increases were slight, and due to the timing, not comparable, but these trends are interesting to note, and may warrant continued monitoring.

Table 5. Upper Feather River Nutrients

Fig2 Map#	Station Name	Date	Time (PST)	Diss. NO2+NO3 (mg/L)	Total NH3 (mg/L)	Diss. Ortho.-PO4 (mg/L)	Total P (mg/L)
3	NF Feather ab Lake Almano	6/19/01	1330	<0.05	ND	0.03	0.05
	NF Feather ab Lake Almano	9/10/03	640	ND	ND	0.03	0.04
1	Goodrich C	6/21/01	1225	<0.05	ND	0.01	0.03
2	Butt C	6/19/01	1420	0.05	ND	0.01	0.04
	Butt C	9/10/03	740	ND	ND	<.01	<.02
25	NF Feather R ab EBNFFR	6/20/01	1420	0.05	ND	<0.01	0.06
	NF Feather R ab EBNFFR	9/11/03	645	ND	ND	<.01	<.02
5	Last Chance C @ Murdock	6/21/01	720	<0.05	ND	<0.01	0.04
	Last Chance C @ Murdock	9/10/03	1050	ND	ND	0.01	<.02
8	Red Clover C ab Indian	6/21/01	825	<0.05	ND	<0.01	0.03
	Red Clover C ab Indian	9/10/03	1200	ND	ND	0.01	0.03
10	Indian C AB Flournoy Br	6/21/01	900	<0.05	ND	0.01	0.04
	Indian C AB Flournoy Br	9/10/03	1230	ND	ND	0.02	0.03
11	Indian C @ Taylorsville	6/21/01	940	<0.05	ND	<0.01	0.01
	Indian C A Taylorsville	9/10/03	1300	ND	ND	<.01	<.02
12	Lights C A Mouth	6/19/01	1550	<0.05	0.1	0.03	0.08
	Lights C A Mouth	9/10/03	920	ND	ND	0.01	0.04
13	Wolf C MR	6/19/01	1500	<0.05	ND	0.02	0.05
	Wolf C MR	9/10/03	835	ND	ND	<.01	<.02
14	Indian C ab Spanish C	6/21/01	1010	<0.05	ND	0.02	0.02
	Indian C AB Spanish C	9/10/03	1330	ND	ND	0.03	0.04
15	Rock C NR Mouth	6/20/01	1115	0.05	ND	<0.01	<0.01
	Rock C NR Mouth	9/9/03	1315	ND	ND	<.01	<.02
18	Greenhorn C A Mouth	6/20/01	1200	<0.05	ND	<0.01	<0.01
	Greenhorn C A Mouth	9/9/03	1210	ND	ND	<.01	<.02
17	Spanish C ab Greenhorn C	6/20/01	1220	0.17	ND	0.02	0.04
	Spanish C AB Greenhorn C	9/9/03	1245	ND	ND	0.01	0.03
19	Spanish C ab Indian C	6/20/01	1330	0.05	ND	<0.01	<0.01
	Spanish C AB Indian C	9/11/03	800	ND	ND	<.01	<.02
20	EBNF Feather ab NFFR	6/20/01	1450	<0.05	ND	0.01	<0.01
	EBNF Feather ab NFFR	9/11/03	715	ND	ND	<.01	<.02
21	MF Feather R @ Beckwourth	6/20/01	700	0.11	0.2	0.01	0.81
22	Sulphur C A Clio	6/20/01	740	0.28	0.2	0.09	0.15
	Sulphur C A Clio	9/9/03	845	ND	ND	0.04	0.06
23	Jamison C nr Two Rivers	6/20/01	810	<0.05	ND	0.01	<0.01
	Jamison C nr Two Rivers	9/9/03	940	ND	ND	<.01	<.02
24	MF Feather R ab Nelson C	6/20/01	910	<0.05	ND	<0.01	0.13
	MF Feather R ab Nelson C	9/9/03	1120	ND	ND	<.01	<.02
	2003 detection limit			0.25 (each)	0.1	0.01	0.02

2003 Nitrate and nitrite measured separately
by Alpha Analytical, Inc (Sparks, NV) ND = Not detected
If they had been analyzed together, perhaps they would've been able to detect?
So, dissolved NO2+NO3 isn't comparable between 2001 and 2003
Phosphate tests were analyzed by Sierra Environmental Monitoring (Reno, NV)

Metals

Table 6 displays total metal (not dissolved) analysis results. Here again, detection limits between 2001 and 2003 differed greatly.

- The Middle Fork at Beckwourth had high levels of many metals in 2001, but there was not enough water to sample that site in 2003.
- Aluminum was highest on the Middle Fork at Beckwourth, Last Chance Cr and Lights Cr in 2001. It was only detectable at Lights Cr in 2003, at a detection limit of 250 ppm. 15 of 20 sites were less than 250 ppm in 2001. Depending on which water quality objective level is used for aluminum, several sites did not meet the objective.
- Cadmium, copper, iron, lead, silver and zinc were highest in the Middle Fork at Beckwourth and Lights Cr in 2001. All were within water quality objectives, except copper at Lights Cr, and numerous sites for iron, depending on which objective level is used. None of those metals were detected in 2003, except for copper at Lights Cr and iron at numerous sites.
- Manganese levels were higher than Basin Plan Objectives at Lights, Sulphur, Last Chance, Indian above Spanish, and Middle Fork at Beckwourth in 2001, and, in 2003, at Lights, Sulphur, Indian above Spanish, Greenhorn, and Spanish above Greenhorn.
- Mercury was undetected in 2003 (at a detection limit of 200 ppb), and was highest at Wolf and Jamison Creeks in 2001, but within all water quality objectives.
- Arsenic was highest in 2001 and 2003 at the mouth of the East Branch, but within Basin Plan Objectives.
- Nickel was highest at three of the four sites in the Spanish Cr watershed in 2001. Selenium was highest at the East Branch North Fork and Sulphur Cr in 2001. At all sites, nickel and selenium were undetected in 2003, and were within water quality objectives in 2001.

Bacteria

Table 7 displays coliform analysis results. As described in the table, results between years at each site are not comparable because of the different methods used.

For total coliform, the eight highest sites in 2001 (in order) were Rock, Butt, Greenhorn, Indian above Flournoy, North Fork above Almanor, Spanish above Indian, and Indian above Taylorsville. In 2003, the eight highest sites were (order cannot be discerned from data) Rock, Indian above Flournoy, Spanish above Indian, Spanish above Greenhorn, Sulphur, Middle Fork at Nelson Pt, Wolf, and Lights. Only three of those sites (Rock, Indian above Flournoy, and Spanish above Indian) are common to both years.

For fecal coliform, Middle Fork at Beckwourth, Goodrich, Sulphur, Greenhorn and Lights were the highest (in that order) in 2001. In 2003, Wolf, Lights, Sulphur, Greenhorn, and Spanish above Greenhorn were the highest. (Middle Fork at Beckwourth and Goodrich were not sampled in 2003). Sulphur, Greenhorn and Lights Creeks were high in both years. The high total coliform sites do not correspond to the high fecal coliform sites.

Minerals

Table 8 displays minerals analysis from 2001 samples. Minerals were not analyzed in 2003.

Table 6. Upper Feather River Total Metals

Fig 2 Map#	Station Name	Date	Time (PST)	Al µg/L	As µg/L	Cd µg/L	Cr (tot) µg/L	Cu µg/L	Fe µg/L	Pb µg/L	Mn µg/L	Hg ng/L	Ni µg/L	Se µg/L	Ag µg/L	Zn µg/L
3	NF Feather R ab Lake Almanor	6/19/01	1330	58.7	<0.003	<0.002	0.05	0.19	45.6	<0.019	2	0.67	0.02	<0.08	<0.003	0.14
1	Goodrich C	6/21/01	1225	296	0.191	0.006	0.99	0.77	323	0.062	15.7	0.68	0.12	0.15	<0.003	0.82
2	Butt C	6/19/01	1420	116	0.293	<0.002	0.34	0.39	113	<0.019	7.41	0.96	0.05	0.09	<0.003	0.3
25	NF Feather R ab EBNFFR	6/20/01	1420	53.4	0.885	0.006	0.16	0.37	93.6	0.029	38.6	0.57	0.15	0.14	<0.003	0.33
5	Last Chance @ Murdock	6/21/01	720	702	0.801	0.016	0.26	1.28	777	0.139	87.4	2.25	0.2	<0.08	<0.003	1.38
8	Red Clover C ab Indian	6/21/01	825	40.6	0.833	<0.002	0.06	0.3	38.2	<0.019	3.12	0.8	<0.01	<0.08	<0.003	0.15
10	Indian C @ Flournoy Br	6/21/01	900	20.6	0.722	<0.002	<0.02	0.43	345	<0.019	32.8	0.7	<0.01	<0.08	<0.003	0.1
11	Indian C @ Taylorsville	6/21/01	940	54.4	1.05	0.009	0.06	0.92	94.6	<0.019	22.3	0.51	<0.01	0.12	<0.003	0.24
12	Lights C	6/19/01	1550	620	1.81	0.027	0.35	10.4	955	0.306	118	1.82	0.23	0.18	0.01	2.24
13	Wolf C	6/19/01	1500	67.8	1.27	0.005	0.07	0.46	338	0.043	18.6	3.42	0.04	0.15	<0.003	0.46
14	Indian C ab Spanish C	6/21/01	1010	165	3.08	0.004	0.37	1.99	165	0.06	70.7	1.04	<0.01	0.19	<0.003	0.57
15	Rock C	6/20/01	1115	12.9	0.292	0.002	0.11	0.22	25.1	<0.019	2.08	0.95	2.98	0.08	<0.003	0.08
18	Greenhorn C	6/20/01	1200	58.4	0.824	<0.002	0.28	0.53	365	0.023	48.9	0.66	0.05	0.17	<0.003	0.34
17	Spanish C ab Greenhorn C	6/20/01	1220	77.9	0.321	0.004	0.33	0.43	258	0.024	47.7	1.55	3.42	<0.08	<0.003	0.43
19	Spanish C ab Indian C	6/20/01	1330	42.4	0.623	<0.002	0.28	0.5	149	0.022	17.2	1.99	1.12	<0.08	<0.003	0.24
20	East Branch NF Feather R ab NFFR	6/20/01	1450	38.3	5.71	0.003	0.27	1.02	70.9	0.02	24.2	1.56	0.79	0.26	<0.003	0.25
21	MF Feather R @ Beckwourth	6/20/01	700	2390	2.32	0.038	1.09	2.85	2640	0.961	58.3	2.16	0.65	0.22	0.008	5.06
22	Sulphur C	6/20/01	740	81.8	0.483	0.005	0.04	0.7	562	0.03	53.8	0.65	0.02	0.23	<0.003	0.53
23	Jamison C	6/20/01	810	37.8	0.683	0.011	0.23	0.34	36.9	0.121	1.23	3.03	<0.01	<0.08	<0.003	0.35
24	MF Feather R ab Nelson C	6/20/01	910	28.5	0.887	0.004	0.06	0.57	91.4	0.068	21.3	1.92	<0.01	0.12	<0.003	0.18
3	NF Feather R AB Lake Almanor	9/10/03	640	ND	ND	ND	ND	ND	ND	ND	ND	<200	ND	ND	ND	ND
2	Butt C	9/10/03	740	ND	ND	ND	ND	ND	ND	ND	6.9	<200	ND	ND	ND	ND
25	NF FR AB EBNF FR	9/11/03	645	ND	ND	ND	ND	ND	1100	ND	34	<200	ND	ND	ND	ND
5	Last Chance @ Murdock	9/10/03	1050	ND	ND	ND	ND	ND	ND	ND	40	<200	ND	ND	ND	ND
8	Red Clover C abv Indian	9/10/03	1200	ND	ND	ND	ND	ND	ND	ND	15	<200	ND	ND	ND	ND
10	Indian C AB Flournoy Br	9/10/03	1230	ND	ND	ND	ND	ND	510	ND	26	<200	ND	ND	ND	ND
11	Indian C A Taylorsville	9/10/03	1300	ND	ND	ND	ND	ND	ND	ND	24	<200	ND	ND	ND	ND
12	Lights C A Mouth	9/10/03	920	730	ND	ND	ND	12	810	ND	100	<200	ND	ND	ND	ND
13	Wolf C NR Greenville	9/10/03	835	ND	ND	ND	ND	ND	3200	ND	44	<200	ND	ND	ND	ND
14	Indian C AB Spanish C	9/10/03	1330	ND	ND	ND	ND	ND	600	ND	65	<200	ND	ND	ND	ND
15	Rock C NR Mouth	9/9/03	1315	ND	ND	ND	ND	ND	ND	ND	ND	<200	ND	ND	ND	ND
18	Greenhorn C A Mouth	9/9/03	1210	ND	ND	ND	ND	ND	740	ND	170	<200	ND	ND	ND	ND
17	Spanish C AB Greenhorn C	9/9/03	1245	ND	ND	ND	ND	ND	ND	ND	63	<200	ND	ND	ND	ND
19	Spanish C AB Indian C	9/11/03	800	ND	ND	ND	ND	ND	ND	ND	23	<200	ND	ND	ND	ND
20	EBNF FR AB NF FR	9/11/03	715	ND	8.3	ND	ND	ND	ND	ND	16	<200	ND	ND	ND	ND
22	Sulphur C A Clio	9/9/03	845	ND	ND	ND	ND	ND	700	ND	66	<200	ND	ND	ND	ND
23	Jamison C nr Two Rivers	9/9/03	940	ND	ND	ND	ND	ND	ND	ND	ND	<200	ND	ND	ND	ND
24	MFFeather R ab Nelson Cr	9/9/03	1120	ND	ND	ND	ND	ND	ND	ND	37	<200	ND	ND	ND	ND
	2003 detection limits			250	5	5	5	5	500	5	5	200	5	5	5	50

analyzed at Alpha Analytical (Sparks, NV)

ml/l = 0.001 liters = ppt

micrograms/l = 0.000 001 liters = ppm

ng/l = .000 000 001 liters = ppb

all 2003 metals analyzed by Alpha Analytical, Inc (Sparks, NV), except Hg, by Sierra Env. Monitoring, R

Table 7. Upper Feather River Coliform

Fig 2 Map #	Station Name	Date	Time	Total Sample Size	Total Coliform: Sample Volume Filtered	Total Coliform: # of colonies	Total Coliform: # of colonies /100 ml	Fecal Coliform: Sample Volume Filtered	Fecal Coliform: # of colonies	Fecal Coliform: # of colonies /100 ml
3	NF Feather R ab Lake Almanor	6/19/01	1330	200	100	31	31	100	37	37
1	Goodrich C	6/21/01	1225	200	100	6	6	100	166	166
2	Butt C	6/19/01	1420	200	100	62	62	100	59	59
25	NF Feather R ab EBNFFR	6/20/01	1420	200	100	26	26	100	0	0
5	Last Chance @ Murdock	6/21/01	720	200	100	8	8	100	19	19
8	Red Clover abv Indian	6/21/01	825	200	100	21	21	100	1	1
10	Indian C @ Flournoy Br	6/21/01	900	200	100	48	48	100	56	56
11	Indian C @ Taylorsville	6/21/01	940	200	100	23	23	100	27	27
12	Lights C	6/19/01	1550	200	100	0*	0*	100	93	93
13	Wolf C	6/19/01	1500	200	100	12	12	100	50	50
14	Indian C ab Spanish C	6/21/01	1010	200	100	19	19	100	3	3
15	Rock C	6/20/01	1115	200	100	92	92	100	1	1
18	Greenhorn C	6/20/01	1200	200	100	49	49	100	148	148
17	Spanish C ab Greenhorn C	6/20/01	1220	200	100	5	5	100	44	44
19	Spanish C ab Indian C	6/20/01	1330	200	100	24	24	100	7	7
20	East Branch NF Feather R ab NFFR	6/20/01	1450	200	100	16	16	100	1	1
21	MF Feather R @ Beckwourth	6/20/01	700	200	100	**	**	50	302	604
22	Sulphur C	6/20/01	740	200	100	5	5	100	158	158
23	Jamison C	6/20/01	810	200	100	12	12	100	1	1
24	MF Feather R ab Nelson C	6/20/01	910	200	100	19	19	100	0	0
	Blank			200	100	0	0	100	0	0

* = Solid growth on plate, but no total colonies

** = Solid growth (may have inhibited total colonies)

				MPN/100ml	MPN/100ml
3	NF Feather R AB Lake Almanor	9/10/03	640	110	110
2	Butt C	9/10/03	740	30	30
25	NF FR AB EBNF FR	9/11/03	645	500	4
5	Last Chance @ Murdock	9/10/03	1050	280	80
8	Red Clover abv Indian	9/10/03	1200	170	4
10	Indian C AB Flournoy Br	9/10/03	1230	>=1600	280
11	Indian C A Taylorsville	9/10/03	1300	50	23
12	Lights C A Mouth	9/10/03	920	>=1600	>=1600
13	Wolf C NR Greenville	9/10/03	835	>=1600	>=1600
14	Indian C AB Spanish C	9/10/03	1330	900	23
15	Rock C NR Mouth	9/9/03	1315	>=1600	<2
18	Greenhorn C A Mouth	9/9/03	1210	500	300
17	Spanish C AB Greenhorn C	9/9/03	1245	>=1600	300
19	Spanish C AB Indian C	9/11/03	800	>=1600	26
20	EBNF FR AB NF FR	9/11/03	715	80	13
22	Sulphur C A Clio	9/9/03	845	>=1600	900
23	Jamison C nr Two Rivers	9/9/03	940	60	<2
24	MFFeather abv Nelson	9/9/03	1120	>=1600	<2

methods comment: 2001 data is not that comparable to 2003 data because they used different methods. 2003 at Henrici used 15 tube fermentation, and no filtering. Without filtering, you would expect the number of colonies to be greater. Also, with the tube, the number of colonies is "most probable number", and is a statistical number based on the number of gas bubbles rising from the tube.

Table 8. UPPER FEATHER RIVER MINERALS

Station Name	Date	Time (PST)	Diss Ca (mg/L)	Diss Mg (mg/L)	Diss Na (mg/L)	Diss K (mg/L)	Diss SO4 (mg/L)	Diss Cl (mg/L)	Diss B (mg/L)	Diss Hardness as CaCO3 mg/L
NF Feather R ab Lake Almanor	6/19/01	1330	5	3	5	1.8	<1.0	<1.0	<0.1	25
Goodrich C	6/21/01	1225	13	5	3	0.6	<1.0	<1.0	<0.1	53
Butt C	6/19/01	1420	13	6	5	1.3	<1.0	<1.0	<0.1	57
NF Feather R ab EBNFFR	6/20/01	1420	13	6	5	1.2	5	<1.0	<0.1	57
Last Chance @ Murdock	6/21/01	720	17	5	10	2.7	<1.0	<1.0	<0.1	63
Red Clover abv Indian	6/21/01	825	18	7	8	2	3	1	<0.1	74
Indian C @ Flournoy Br	6/21/01	900	16	6	8	2.2	2	1	<0.1	65
Indian C @ Taylorsville	6/21/01	940	16	5	6	1.3	4	1	<0.1	61
Lights C	6/19/01	1550	17	5	8	1.6	5	<1.0	<0.1	63
Wolf C	6/19/01	1500	16	6	6	0.6	4	1	<0.1	65
Indian C ab Spanish C	6/21/01	1010	24	8	13	1.6	6	5	0.1	93
Rock C	6/20/01	1115	10	6	5	0.6	2	2	<0.1	50
Greenhorn C	6/20/01	1200	20	7	8	0.8	3	3	<0.1	79
Spanish C ab Greenhorn C	6/20/01	1220	13	7	6	1.1	3	3	<0.1	61
Spanish C ab Indian C	6/20/01	1330	17	7	7	0.7	3	2	<0.1	72
East Branch NF Feather R ab NF	6/20/01	1450	22	9	13	1.3	7	5	0.2	92
MF Feather R @ Beckwourth	6/20/01	700	24	8	20	4	3	7	0.1	93
Sulphur C	6/20/01	740	23	4	8	1.7	3	<1.0	<0.1	74
Jamison C	6/20/01	810	16	3	2	<0.5	2	<1.0	<0.1	52
MF Feather R ab Nelson C	6/20/01	910	17	4	6	1	3	1	<0.1	59

Table 9 Summary of water quality objectives and criteria (ug/L)

(revised 5/25/01)

Parameter	RWQCB	U.S. EPA or California DHS		Agricultural	USEPA California Toxics Rule Criteria for Freshwater Aquatic		USEPA National Toxics Rule Criteria for		USEPA National Ambient Water Quality Criteria	
		Primary	Secondary		Dissolved Continuous	Dissolved Maximum	Total Continuous	Total Maximum	Continuous Concentration	Maximum Concentration
Aluminum		1000	200	5000					87	750
Ammonia		500 [2]							4,15 [3]	24,1 [3, 7]
Arsenic	10 [4]	50 [16]		100	150	340	190	360	150 [4]	340 [4]
Boron				700						
Cadmium	0,22 [4]	5		10	2,2 [6]	4,3 [6]	1,1 [6]	3,9 [6]	2,2 [4, 6]	4,3 [4, 6]
Chloride			500.000	106.000						
Chromium		50 [8]		100 [9]	11 [10]	16 [10]	11	16	11 [10]	16 [10]
Conductivity			1.600	700						
Copper	5,6 [4]	1.300	1.000	200	9 [6]	13 [6]	12 [6]	18 [6]	9,0 [4, 6]	13 [4, 6]
Hardness										
Iron	300 [4]		300	5.000						1.000
Lead		15		5.000	2,5 [6]	65 [6]	3,2 [6]	82 [6]	2,5 [4, 6]	65 [4, 6]
Manganese	50 [4]		50	200						
Mercury		2				0,051 [15]	0,012	2,4	0,77 [12]	1,4 [4]
Nickel		100		200	52 [6]	470 [6]	160 [6]	1400 [6]	52 [4, 6]	470 [4, 6]
Nitrate (as N)		10.000								
pH [13]	6.5 - 8.5		6.5 - 8.5							6.5 - 9.0
Selenium		50		20	5 [12]	20 [12]	5	20	5 [12]	[12, 17]
Silver	10 [4]		100			3,4 [6]		4,1		3,4 [4, 6, 18]
Zinc	16 [4]		5.000	2.000	120 [6]	120 [6]	110	120	120 [4, 6]	120 [4, 6]

Footnotes:

1 From Food and Agriculture Organization of the United Nations, 1985 Water Quality for Agriculture

2 Taste and odor threshold

3 pH and temperature dependent; value shown based on ph 7.0 and temperature of 20 C

4 As dissolved

5 Million fibers per liter longer than 10 microns

6 Hardness dependent; value indicated is based on hardness of 100 mg/L as CaCO3

7 Based on pH of 7.0 and temperature of 20 C; maximum allowable concentration if salmonids present

8 Total chromium

9 Chromium (VI)

10 Criteria are for chromium (VI) as dissolved; criteria for chromium (III) as dissolved is hardness dependent

11 umhos/cm

12 As total recoverable

13 Standard pH units

14 Adjusted sodium adsorption ratio

15 For protection of human health from consumption of aquatic organisms

16 EPA adopted standard of 10 in January 2001; Pres. Bush halted implementation

17 Based on selenite and selenate fractions

18 Instantaneous maximum

Turbidity

Figures 3-6 display turbidity and flow measurements from the two continuous recording turbidimeters on Indian Cr at the Taylorsville Bridge, and on Spanish Cr at the Gansner Bridge for 2002and 2003. Changes in turbidity follow changes in flow fairly closely. The blip in turbidity at Spanish Creek in Oct. 2002 is probably due to tributary/road drainage construction activities just upstream of the sensor. Based on volunteer, staff, and subcontractor sampling efforts, regression curves were also plotted for TSS and turbidity for Indian and Spanish Creeks (Figures 7 and 8). Table 10 displays volunteer and staff turbidity monitoring at three locations along Greenhorn Cr and three locations along Spanish Creek, which shows, almost always, an increase in turbidity from the upstream sites to the downstream sites.

Turbidity monitoring has been funded under several funding sources. The primary source was Prop. 204 funding, with the expectation that the turbidity/TSS relationship, and round-the-clock event monitoring could help quantify the amount of sediment coming into Indian Valley from specific tributaries. These data were to be used to assist in channel restoration design efforts for Indian Cr. Large-scale restoration has not yet occurred on Indian Cr, but the data (including a rough quantification of sediment based on the turbidity vs TSS regression equation) were reported in the 204 final report, which is available on the CRM website at feather-river-crm.org. Those results are also briefly mentioned in the discussion by site.

The turbidity/TSS sampling in American Valley did not include depth-integrated sampling, however, the Indian Cr effort did. Neither effort included multiple cells across the channel, but locations on Indian Cr were determined in the 1980's by Mike Kossow and Craig Bolger of PG&E to be the most representative cell across the cross-section for average sediment load.

Figure 3. Average Daily Flow and Turbidity in Indian Creek at Taylorsville Water Year 2002

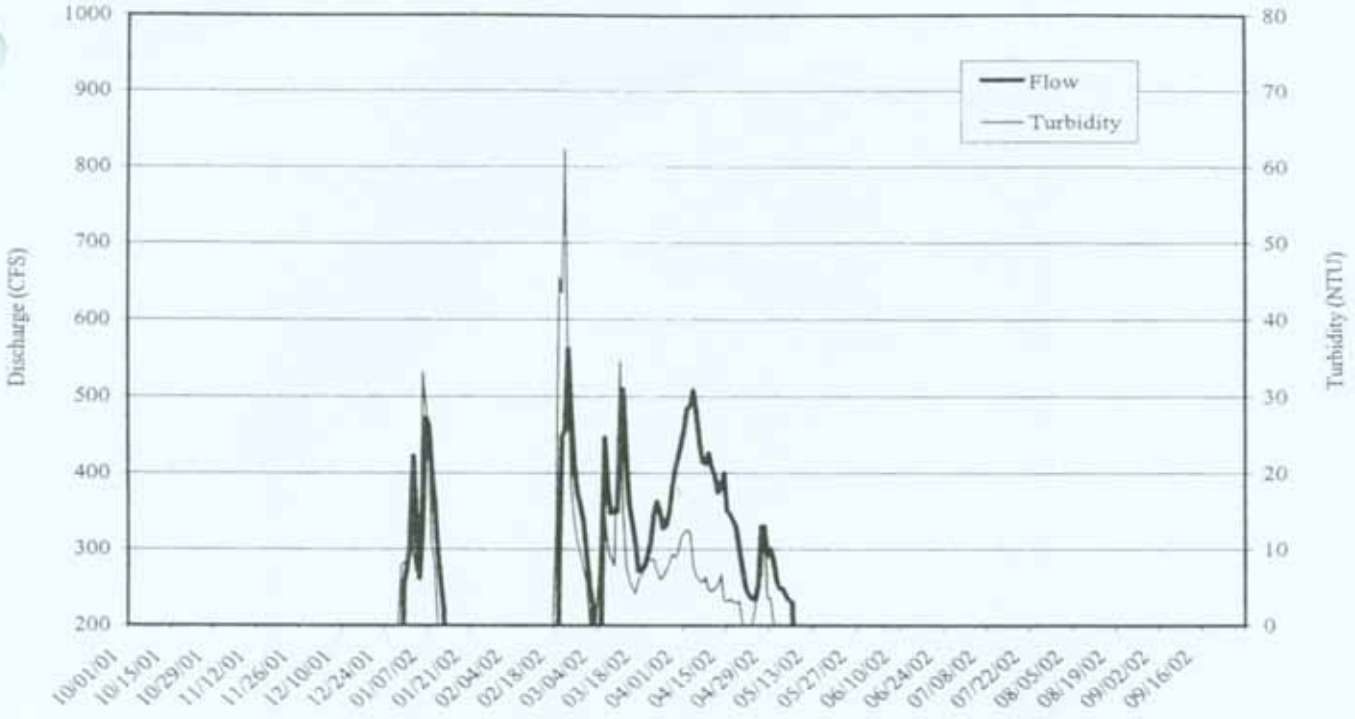


Figure 4. Average daily flow & Turbidity in Indian Creek at Taylorsville- Water Year 2003

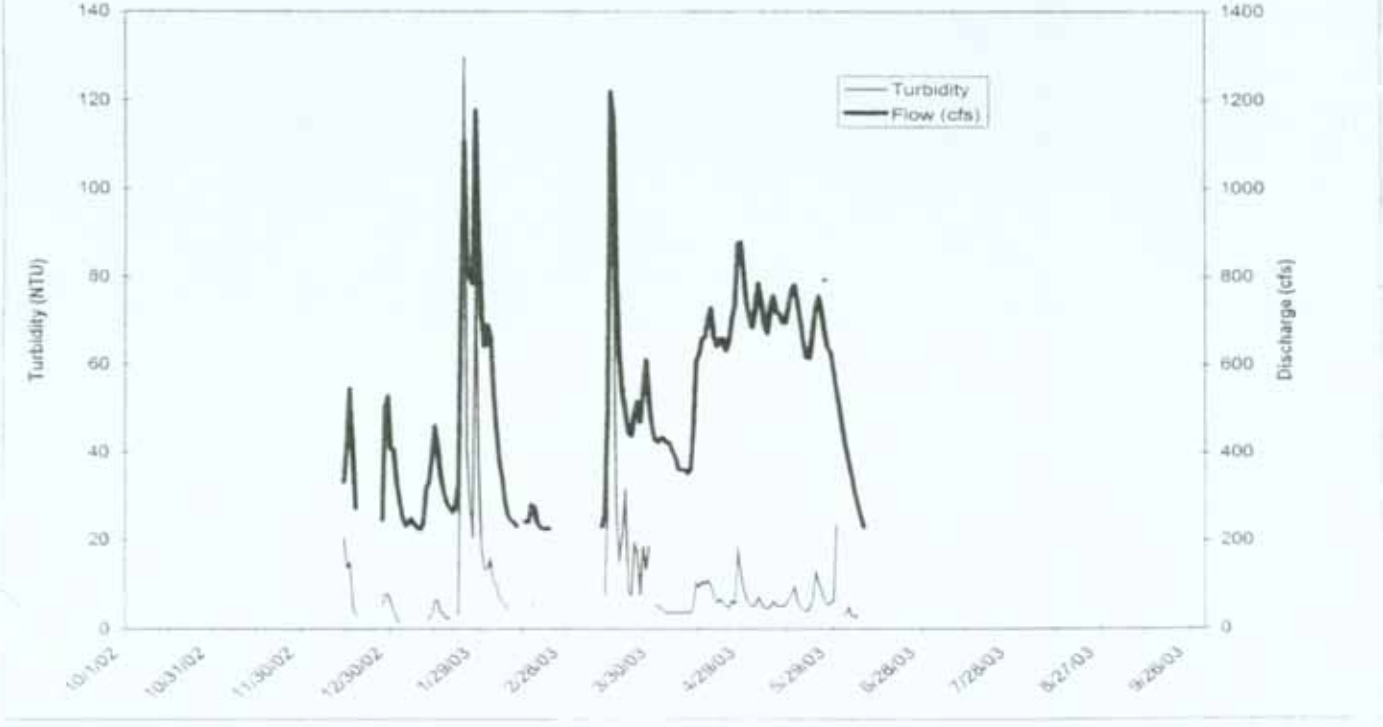


Figure 5. Average Daily Flow and Turbidity in Spanish Creek @ Highway 70 Bridge- Water Year 2002

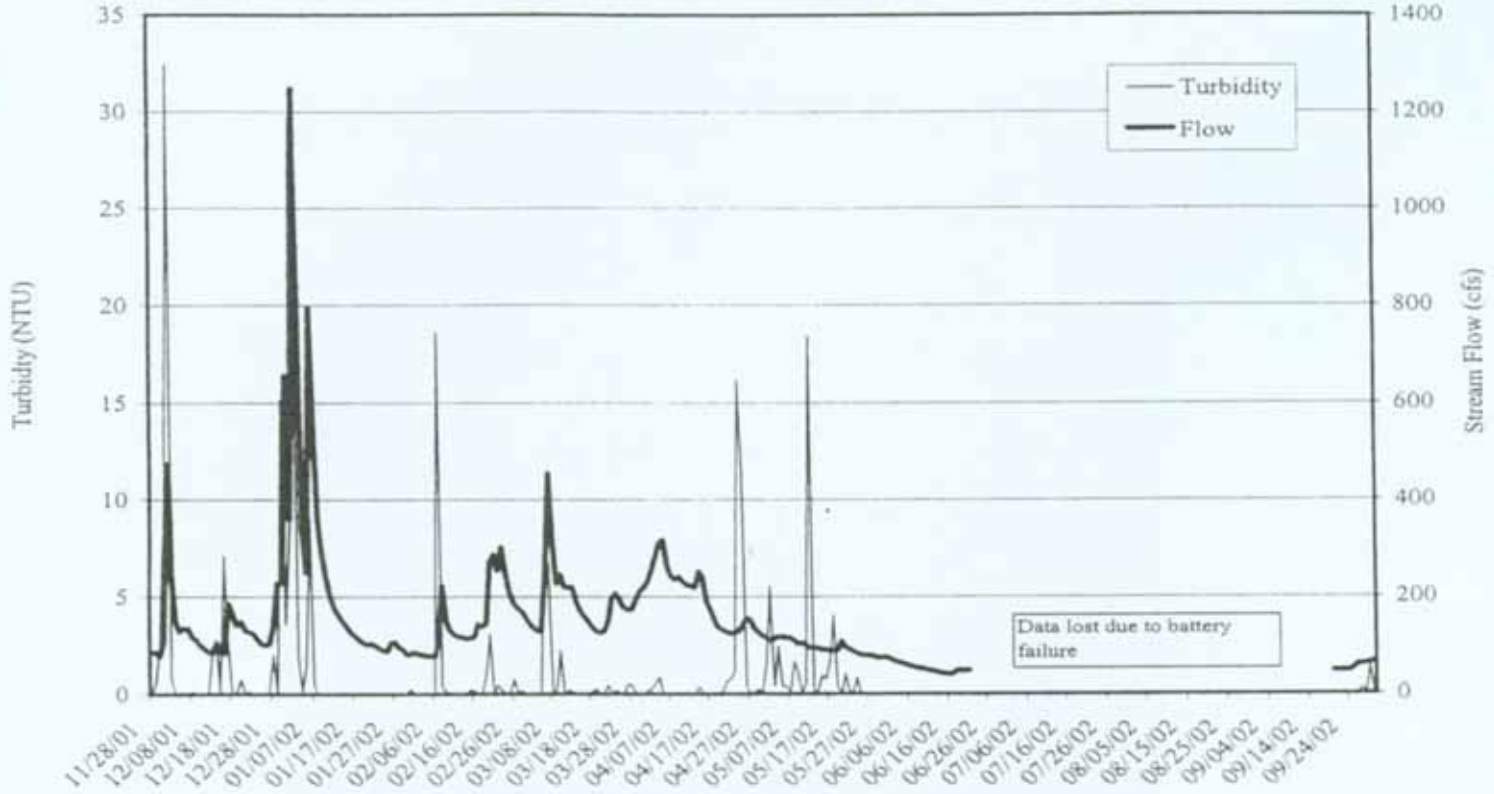


Figure 6. Average Daily Flow & Turbidity in Spanish Creek at Hwy 70 Bridge - Water Year 2003

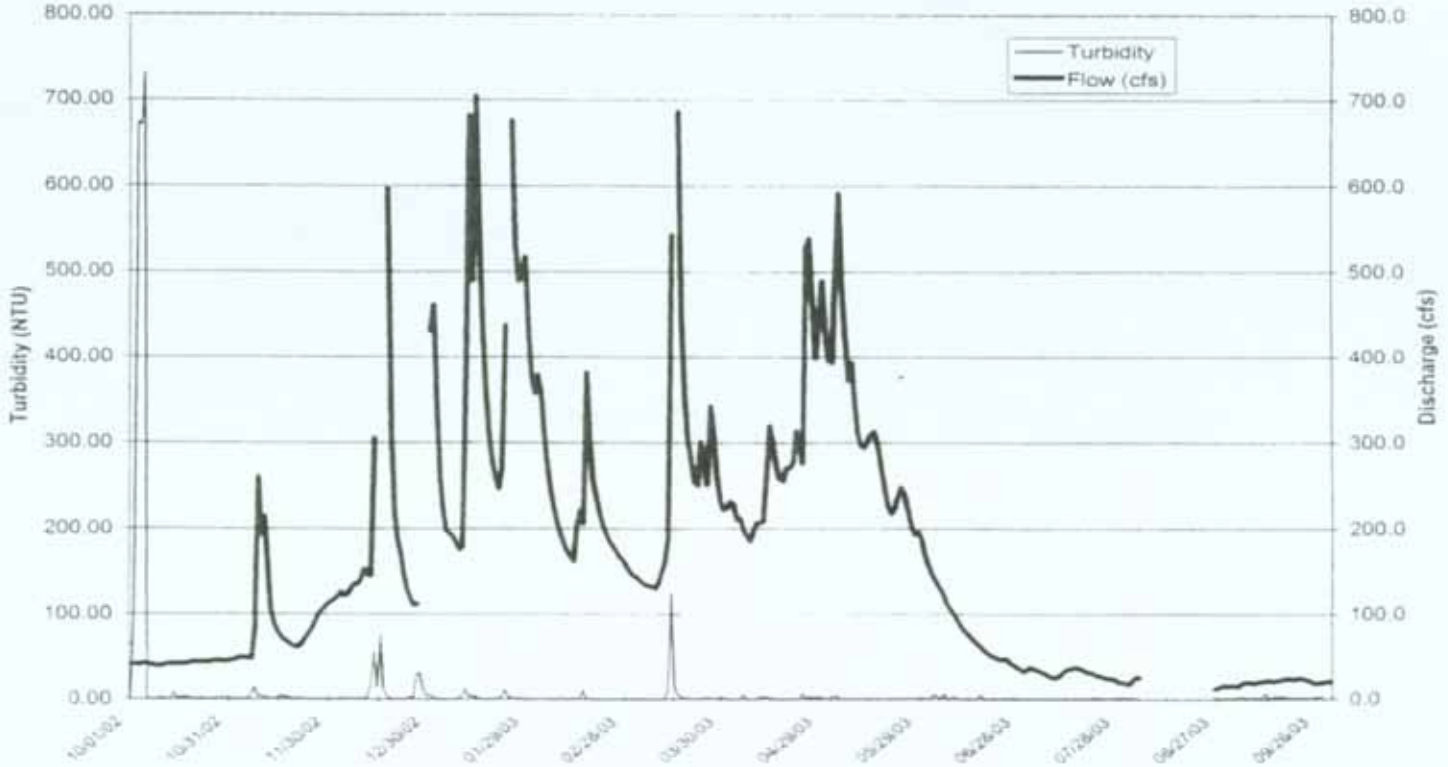


Figure 7. Regression Analysis of TSS versus Turbidity Indian Cr WY 2000

Figure 8. Regression Analysis of TSS vs. Turbidity Spanish and Greenhorn Creeks WY2003

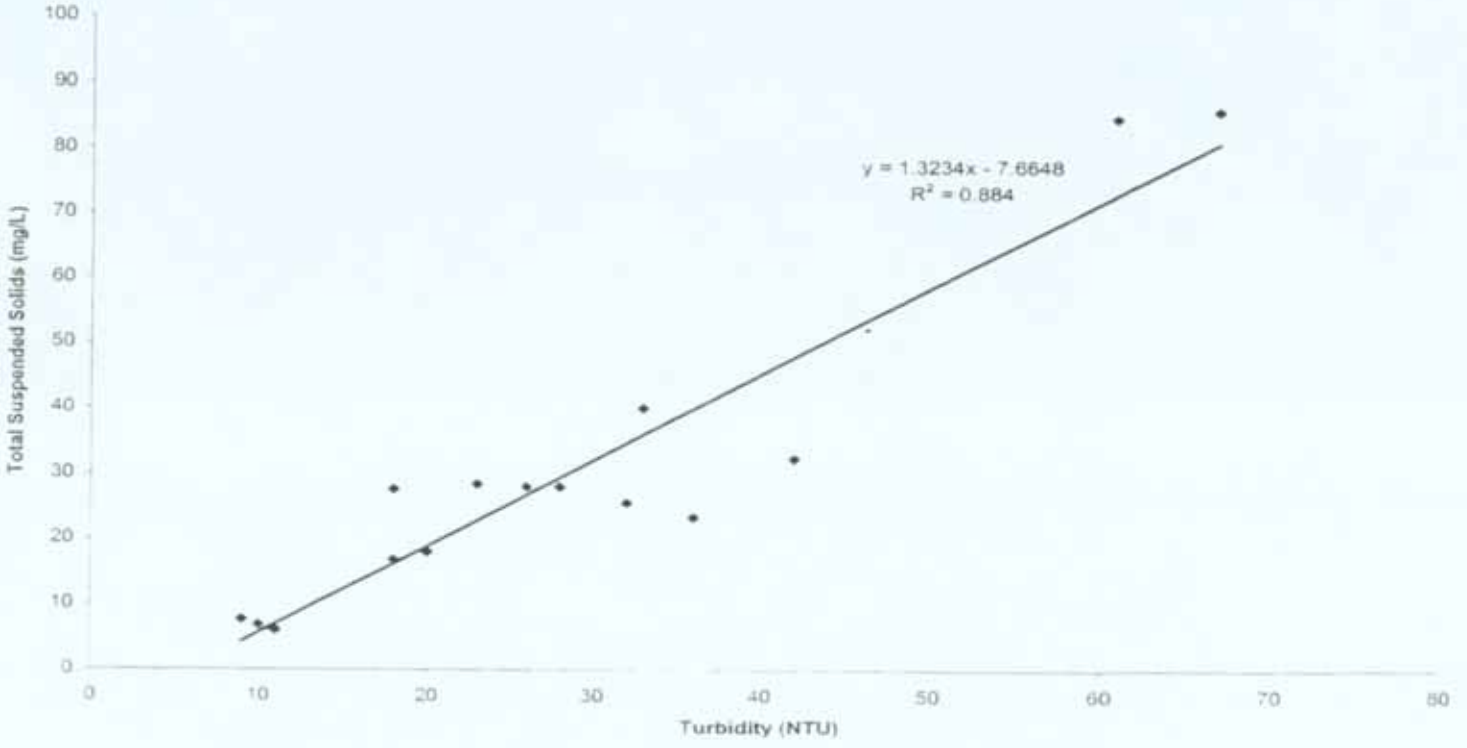


Table 10. Random American Valley (Spanish and Greenhorn Creeks) Turbidity Monitoring (Including Volunteer M

time is in international format

	date	Greenhorn @ gage abv Farnworth			Greenhorn at Labbe's		Greenhorn @ mouth			Spanish abv aggregate		Spanish @ hwy70 bridge			Spanish acw Greenhorn	
		time	gh	NTU's	time	ntu's	time	NTU's		time	NTU's	time	gh	NTU's	time	NTU's
												740		1.5		
	3/6/02	1640	0.66	10			1720	10		1705	12	1735		14	1720	21
	3/7/02	845	0.75	8			900	12		830	4	946		5	900	12
	3/7/02	1530	0.91	16			1540	17		1600	12	1610		14	1540	21
no storm	9/26/02	1100	0.2	0.6												
no storm	12/9/02	1300	0.28	0.8												
	12/13/02	1625	0.45	7			1640	8		1710	27	1610		21	1645	11
		1600	0.44	4												
	12/14/02	1040	0.73	24			1029	39		1005	45	1100		48	1026	111
	12/14/02	1519	0.64	10			1505	21		1610	19	1440		16	1500	59
		1600	0.68	10												
	12/15/02	1550	0.75	12			1537	15		1607	10	1510		6	1530	25
		1700	0.76	8												
	12/16/02	1001	1.27	23			950	64		927	59	1015		78	945	101
	12/16/02	1600	1.14	13			1600	56		1626	20	1535		40	1607	61
	12/17/02	943	0.75	8	900	13	932	17		959	7	905	2.8	11.5	928	23
	12/17/02	1620	0.7	5	1500	15	1632	9		1657	4	1615		4	1636	16
	12/18/02	1230	0.57	3												
	12/19/02	1630	0.5	3												
	12/27/02	1102	0.49	11			1049	20		1118	23	1133		28	1046	67
	12/27/02	1618	0.65	9			1632	33		1652	32	1603		42	1634	61
	12/28/02	1304	0.87	10			1318	18		1245	18	1335		26	1320	36
	12/28/02	1700	1.04	12												
	12/29/02	1640	0.82	4												
	12/30/02	1500	0.7	3												
	12/31/02	1600	0.84	3												
	1/10/03	1345	0.74	5												
no storm	1/16/03	1330	0.68	3												
	1/24/03	1402	0.99	6						1450	2					
	1/25/03											1629		1.5		
	3/14/03	1540	0.8	7			1516	4.82							1522	5.51
	3/15/03	1250	1.85	44.7			1129	140.5		1307	33.1	1110	above	57.2	1126	119.2
	3/15/03	1540	1.6	35												
	3/17/03	1300	0.94	6.7												
	3/23/03	1430	0.7	2												
	4/2/03	1400	0.7	1.2												
	4/12/03	1409	0.95	11			1346	10		1427	4	1255		4	1344	6
	4/24/03	1330	1.1	8												
	4/25/03	1700	1.12	7.7												
	4/28/03	1650	1.12	4.7												

Aquatic Biota

Fish Populations

Table 11 displays annual fish population summary data from electroshock surveys in the late summer of 2001 and 2003. An attempt was made both years to choose a sampling section that represented the overall habitat composition of the entire monitoring reach. However, crews were different between years, and the 2001 sampling areas were not noted. It should be noted that the difference in populations and fish size between years could be due more to a difference in sampling location than a difference in habitat conditions. The most noteworthy results are the fish data are:

- No salmonids were detected in either year at Wolf, Lights, and Last Chance Creeks.
- Looking at all the sites together, the general trend of increasing fish biomass from 2001 to 2003 is probably a reflection of the increased flow between those years.
- At Butt Cr, in 2003, salmonid lengths decreased, and suckers appeared.

Because of the large volume of water at some sites, fish have never been sampled, and Jamison Creek and Red Clover Cr at Drum Bridge were only sampled in 2001. At every site with salmonids, salmonid biomass increased from 2001 to 2003, along with an increase in non-salmonids at most sites. Little to no salmonids were present in 2001 in Indian Cr above Flournoy Bridge, and below the Taylorsville Bridge, but were well represented in 2003. While not shown in Table 11, fish lengths increased significantly for salmonids at Indian Cr above Flournoy Bridge and Sulphur Cr.

Table 11. Fish biomass in Monitoring Reaches

Fig 2 Map #	Reach	Year	Rainbow trout biomass ml/100 yds	Brown trout biomass ml/100yds	Non-salmonid biomass ml/100 yds
	Alluvial Channels				
2	Butt (CRM)	2001	1212	2008	1314
		2003	5266	783	8290**
13	Wolf	2001	0	0	670
		2003	0	0	250
12	Lights	2001	0	0	850
		2003	0	0	283
5	Last Chance	2001	0	0	1560
		2003	0	0	2000
10	Indian blw Red Clover (F	2001	10	0	18
		2003	2280	70	3929
11	Indian blwTaylorsville Bri	2001	0	0	930**
		2003	365	0	143**
18	Greenhorn	2001	233	47	173
		2003	269	426	917
17	Spanish abv Greenhorn	2001	4	31	1610
		2003	0	115	1121
22	Sulphur	2001	37	0	373
		2003	200	1416	821
	Depositional/ non-alluvial				
15	Rock *	2001	1414*	120*	1400*
		2003	851*	66*	418*
	non-alluvial channel summaries				
8	Red Clover abv Indian (D	2001	64	0	1470
23	Jamison	2001	1240	0	0
		2003	too much water		

* *non-descending catch - data not reliable
*data not comparable between years for Rock Cr:
2001 effort was 2 passes with 2 shockers; 2003 was 1 pass with 1 shocker

Macroinvertebrates

Table 12 displays selected macroinvertebrate metrics for 1999 and 2001. Analysis of macroinvertebrate samples collected in 2003 are not yet complete. As with other parameters, figures generated from macroinvertebrate analysis are primarily useful in trend monitoring.

Definitions of headings in Table 12:
Operational Taxonomic Units (OTU) = The number of taxa arrived at through a formula that considers the percentage of the sample that was identified in the lab. It is the total number of taxa from which EPT taxa and sediment intolerant taxa percentages were calculated.
%EPT taxa = This parameter was calculated for this report by taking the total number of Ephemeroptera, Plecoptera, and Trichoptera taxa provided by the Utah lab, and dividing it by the O.T.U.
Shannon Diversity Index = a commonly used macroinvertebrate index, which becomes primarily useful in trend analysis over time.
Percentage of Wisseman sediment intolerant taxa = This parameter was calculated for this report by taking the total number of Wisseman sediment intolerant taxa, and dividing it by the O.T.U.
Wisseman percentage of assemblage made up by tolerant taxa = an index provided by the National Aquatic Monitoring Center, (along with 53 other metrics).

The following discussion of improvements or declines only refers to changes greater than 10%. Any change less than 10% was considered to be no change. The most noteworthy results for macroinvertebrate analysis are:

- Goodrich Creek and North Fork Feather River above Lake Almanor were the only sites that showed a decline greater than 10% in all five metrics.
- The across the board declining trend in two metrics, and majority declining trend in other metrics, suggests that the difference could be due to the overall decrease in flow volume in 2001.
- The only site that shows more metrics improving than declining is Jamison Cr.

Other trends: Percentage of EPT taxa declined at 14 of the 19 sites. It did not improve at any site. The Wisseman percent of tolerant taxa increased (which is a declining trend) at 18 sites, and decreased (an improving trend) at one site. The other metrics were more ambiguous. The Shannon Diversity Index showed less than a 10% change at 12 of the sites. Total taxa (OTU) improved at five sites, declined at five sites, and showed less than a 10% change at eight sites. The percentage of sediment intolerant taxa increased (an improving trend) at four sites, decreased at 10 sites, and remained the same at four sites. No metric showed an improvement at a majority of sites.

Table 12. Selected Macroinvertebrate Metrics in Monitoring Reaches

Fig 2 Map #	Reach	Year	Operational Taxonomic Units	% EPT taxa	Shannon Diversity Index	Percentage of Wisseman sediment ntolerant taxa	Wisseman % of assemblage made up by tolerant taxa
	Alluvial Channels						
1	Goodrich	1999	29	57	2.4	6	23
		2001	7	14	0.8	0	91
2	Butt (CRM)	1999	37	61	2.5	9	18
		2001	46	60	2.8	8	35
13	Wolf	1999	29	60	2.4	10	4
		2001	28	42	2.2	0	9
12	Lights	1999	27	74	2.6	5	7
		2001	27	45	2.4	5	8
5	Last Chance @ Murdock	1999	21	44	0.98	11	4
		2001	24	24	1.9	6	72
10	Indian blw Red Clover	1999	33	67	2.3	8	9
	(Flournoy Bridge)	2001	37	55	2.2	7	11
11	Indian blw Taylorsville Bri	1999	36	62	2.4	4	2
		2001	36	50	2.7	6	15
18	Greenhorn	1999	40	62	2.7	3	4
		2001	41	52	2.6	5	27
17	Spanish abv Greenhorn	1999	35	60	2.3	6	3
		2001	32	53	2.3	10	9
2	MF Feather @ Beckwour	1999	26	58	2.2	7	7
22	Sulphur	1999	30	62	2.6	12	5
		2001	31	59	2.5	5	36
	Depositional/ non-alluvial channels						
15	Rock	1999	36	54	2.8	3	9
		2001	44	45	2.4	3	56
19	Spanish abv Indian	1999	36	59	2.3	6	4
		2001	28	41	2.3	3	15
	non-alluvial channels						
3	NF Feather abv Almanor	1999	50	61	3.2	6	6
		2001	43	52	2.5	3	9
25	NF Feather abv East Bra	1999	43	52	2.9	6	9
		2001	46	52	3.2	6	13
20	East Branch NF Feather	1999	32	67	2.5	9	11
		2001	34	53	2.7	5	14
8	Red Clover abv Indian (D	1999	32	60	1.9	5	3
		2001	28	51	1.9	5	14
14	Indian abv Spanish	1999	28	66	2.4	2	20
		2001	21	49	1.9	0	12
23	Jamison	1999	29	60	2.4	0	1
		2001	36	61	2.7	3	4
24	MF Feather abv Nelson	1999	29	62	2.4	13	3
		2001	37	52	2.6	7	13

Flow

Flow data contribute to the CRM's understanding of how the major tributaries contribute to flows in the larger systems, such as Indian Creek (i.e. timing and volume). The two primary questions, regarding restoration, that the CRM is seeking to answer with the flow data are: 1) Are restoration projects contributing to a measurable increase (in the larger tributaries) of summer base flows? and 2) Are restoration projects contributing to a measurable attenuation of peak flows (in larger tributaries)?

There are a variety of ways to display and analyze the Continuous Recording flow data. Most of the flow data are presented in Appendix F, and are displayed in the context of precipitation data from Genesee that Jim Wilcox has been collecting since 1998. Other comparisons such as the flow's influence on water temperature, and between station comparisons were considered too exhaustive to include in this report.

In the body of this report, Tables 13a and 13b distill the flow data down to peaks and minimums. Table 13a is organized by year, and Table 13b by station. The tables display the maximum and minimum of running seven-day averages of daily flow, as well as the absolute max and min flow of any hour sampled throughout each year. Seven day averages were used to try and reduce the effects of flashy events, and because seven day averages are in common usage in temperature analysis. The difference between maximum and minimum flows (range) is displayed to try and reduce the effect of different precipitation amounts between years. An improvement in watershed function should be reflected in a smaller range, as well as higher minimum flows. The TAC concurred that concentrating on minimum flows as a primary indicator of improvement (rather than maximum flow attenuation) would help reduce the noise associated with stochastic precipitation events.

The most noteworthy result shown in Tables 13a and 13b is that despite increasing precipitation from 2001 to 2003, Lights Cr has shown a steady decline in the 7-day average minimum flow. Looking at the data in Tables 13a&b in the context of monthly flow and precipitation data (Appendix F), as expected, the 7-day average max, min and range generally follow monthly precipitation. However, one would expect the very minimum flow of the four-year period to be in 2001, the driest year, but the lowest 7-day average didn't show up at Flournoy, Lights and Doyle until 2002. Also, the highest maximum average daily flow was in Feb 2000 at all sites but just above and below Red Clover Creek (which may have been due to the influence of Antelope dam), but the highest precipitation year was 2003. The highest monthly precipitation was in December 2002; the lack of corresponding high flow was probably due to the unsaturated condition of the watershed at that time.

The 2003 bars also show one of the run-off patterns in this watershed. Peak monthly average flows were in April for Last Chance, Red Clover, and Indian Cr at Flournoy (just below Red Clover). For all the other sites it was in May. Last Chance and Red Clover are eastside, and melted a lot faster than the other subwatersheds. They are also in poor condition, without much functional floodplain area to absorb high flows (due to extensive gullying). They are also the highest priority watersheds for large-scale CRM restoration efforts. 2003 was an interesting year in general because of the high spring precipitation that produced relatively high flows into June.

On all the graphs with daily average flow and precipitation data, the flows generally peak with the precipitation, except at Flournoy Bridge in 2003. This station should be checked for accuracy.

Table 13 a. Summary of Flow Data from Permanent Stations Listed by Year

Fig 2 Map #	Station	Water Year	7-day Average Flow Max (CFS)	7-day Average Flow Min (CFS)	7-day Average Flow Range (CFS)	Hourly Average Statistics Maximum Discharge (CFS)	Hourly Average Statistics Minimum Discharge (CFS)	Hourly Average Statistics Mean Discharge (CFS)	Days without sensor error or obstructed flow	Total Data Days	Remarks		
												415	TRUE
												93	TRUE
4	Last ChanceDoyle	2003	92	0.12	92	175	0.03	20.2	365	365		2047	TRUE
7	Red Clover Notson	2003	287	3.22	283	473	1.07	54.4	365	365		867	TRUE
9	Indian abv Red Clvr	2003	239	12.7	227	272 OR[1]	1.96	46.8	365	365	Some days affected by ice, not determined.	3520	TRUE
10	Indian blw Red Clvr	2003	701	24.7	677	1158	16.8	196	305	365	Sensor error in August 2003	302	FALSE
11	Indian @ Tville	2003	909	225	683	1698	223	514	151	365	High flow period only	2774	TRUE
12	Lights	2003	290	0.00	290	630	0.00	76.3	346	365	Several days of zero flow (or near zero)	149	FALSE
13	Wolf	2003	139	1.24	138	211	0.95	31.6	359	365	Beaver activity affects record		
16	Spanish	2003	525	11.8	513	768	11.3	167	335	365	Beaver activity affects record	415	FALSE
												93	TRUE
												2047	TRUE
4	Last ChanceDoyle	2002	66.9	0.07	67	111	0.04	12.6	364	365		867	TRUE
7	Red Clover Notson	2002	38.9	2.80	36	59.3	2.43	7.93	209	209	Lost data due to vandalism	3520	TRUE
9	Indian abv Red Clvr	2002	126	4.08	122	160 OR[1]	1.66	23.4	362	365		302	TRUE
10	Indian blw Red Clvr	2002	343	3.06	340	543	3.06	96.2	359	365		2774	TRUE
11	Indian @ Tville	2002	471	248	223	623	222	348	89	89	High flow period only	149	FALSE
12	Lights	2002	178	0.05	178	267	0.03	41.1	326	365			
13	Wolf	2002	94.7	1.10	94	116	1.08	12.9	222	365		415	
16	Spanish	2002	638	42.6	595	2194 OR[1]	37.8	155	217	227	Installed November 2001, some data lost due to battery failure.	93	FALSE
												2047	TRUE
												867	TRUE
4	Last ChanceDoyle	2001	27.5	0.6	26.9	103	0.41	3.10	364	365		3520	TRUE
7	Red Clover Notson	2001	66.1	2.5	63.6	101	2.13	11.5	365	365		2774	TRUE
9	Indian abv Red Clvr	2001	16.7	3.82	12.9	28.3	3.50	8.84	365	365		149	TRUE
10	Indian blw Red Clvr	2001	174	3.46	170	236	0.20	56.4	365	365			
11	Indian @ Tville	2001	Not enough high flow days			555	255	314	14	15	High flow period only	415	FALSE
12	Lights	2001	93.5	0.10	93.4	200	0.19	16.7	304	365	Some periods with zero flow	93	FALSE
13	Wolf	2001	87.0	0.38	87	Beaver dam	---	---	322	365	Daily average estimated based on regression to Lights Creek	2047	okay
												867	TRUE
												3520	TRUE
4	Last ChanceDoyle	2000	183.8	2.2	181.5	384	2.25	31.0	292	317	Installed 12/23/97, data missing due to installation upgrade	2774	TRUE
7	Red Clover Notson	2000	303.4	4.9	298.5	1354 OR[1]	0.02	64.6	307	316	Installed 10/22/99, t data due to vandalism	149	FALSE
9	Indian abv Red Clvr	2000	208.2	13.7	194.6	239 OR[1]	12.9	51.0	331	331	Installed 11/04/99		
10	Indian blw Red Clvr	2000	660.9	25.5	635.4	2103	21.2	161	331	331	Installed 11/05/99		
11	Indian @ Tville	2000	1055.0	245.1	809.9	3387 OR[1]	245	616	126	130	Installed 10/29/99, high flow period only		
12	Lights	2000	437.6	1.5	436.1	2224 OR[1]	1.18	87.6	278	277	Installed 12/28/99		
13	Wolf	2000	249.0	0.7	248.2	935 OR[1]	0.14	58.6	212	284	Installed 12/21/99		

[1]OR = For peak flows that are "over the rating", the discharge is calculated based on extrapolation of the existing rating table. No measurements are available that define the stage flow relationship during the peak flow event. Therefore, there is no estimate of the relative accuracy of these values.

13b. Summary of Annual Flow Data from Permanent Stations Listed by Station

Fig 2 Map #	Station	Water Year	7-day Average Flow Max (CFS)	7-day Average Flow Min (CFS)	7-day Average Flow Range (CFS)	Hourly Average Statistics Maximum Discharge (CFS)	Hourly Average Statistics Minimum Discharge (CFS)	Hourly Average Statistics Mean Discharge (CFS)	Days without sensor error or obstructed flow	Total Data Days	Remarks		
4	Last Chance Doyle	2000	183.8	2.2	181.5	384	2.25	31.0	292	317	Installed 12/23/97, data missing due to installation upgrade	3520	TRUE
	Last Chance Doyle	2001	27.5	0.6	26.9	103	0.41	3.10	364	365		3520	TRUE
	Last Chance Doyle	2002	66.9	0.07	67	111	0.04	12.6	364	365		3520	TRUE
	Last Chance Doyle	2003	92	0.12	92	175	0.03	20.2	365	365		3520	TRUE
7	Red Clover Notson	2000	303.4	4.9	298.5	1354 OR[1]	0.02	64.6	307	316	Installed 10/22/99, t data due to vandalism	149	FALSE
	Red Clover Notson	2001	66.1	2.5	63.6	101	2.13	11.5	365	365		149	TRUE
	Red Clover Notson	2002	38.9	2.80	36	59.3	2.43	7.93	209	209	Lost data due to vandalism	149	TRUE
	Red Clover Notson	2003	287	3.22	283	473	1.07	54.4	365	365		149	FALSE
9	Indian abv Red Clvr	2000	208.2	13.7	194.6	239 OR[1]	12.9	51.0	331	331	Installed 11/04/99	93	FALSE
	Indian abv Red Clvr	2001	16.7	3.82	12.9	28.3	3.50	8.84	365	365		93	TRUE
	Indian abv Red Clvr	2002	126	4.08	122	160 OR[1]	1.66	23.4	362	365		93	FALSE
	Indian abv Red Clvr	2003	239	12.7	227	272 OR[1]	1.96	46.8	365	365	Some days affected by ice, not determined.	93	FALSE
10	IndianblwRedClver	2000	660.9	25.5	635.4	2103	21.2	161	331	331	Installed 11/05/99	2047	okay
	IndianblwRedClver	2001	174	3.46	170	236	0.20	56.4	365	365		2047	TRUE
	IndianblwRedClver	2002	343	3.06	340	543	3.06	96.2	359	365		2047	TRUE
	IndianblwRedClver	2003	701	24.7	677	1158	16.8	196	305	365	Sensor error in August 2003	2047	TRUE
11	Indian @ Taylorsville	2000	1055.0	245.1	809.9	3387 OR[1]	245	616	126	130	Installed 10/29/99, high flow period only	2774	FALSE
	Indian @ Taylorsville	2001	Not enough high flow days			555	255	314	14	15	High flow period only	2774	TRUE
	Indian @ Taylorsville	2002	471	248	223	623	222	348	89	89	High flow period only	2774	TRUE
	Indian @ Taylorsville	2003	909	225	683	1698	223	514	151	365	High flow period only	2774	TRUE
12	Lights	2000	437.6	1.5	436.1	2224 OR[1]	1.18	87.6	278	277	Installed 12/28/99	867	FALSE
	Lights	2001	93.5	0.10	93.4	200	0.19	16.7	304	365	Some periods with zero flow	867	TRUE
	Lights	2002	178	0.05	178	267	0.03	41.1	326	365		867	TRUE
	Lights	2003	290	0.00	290	630	0.00	76.3	346	365	Several days of zero flow (or near zero)	867	TRUE
26	Wolf	2000	249.0	0.7	248.2	935 OR[1]	0.14	58.6	212	284	Installed 12/21/99	415	FALSE
	Wolf	2001	87.0	0.38	87	Beaver dam	---	---	322	365	Daily average estimated based on regression to Lights Creek	415	
	Wolf	2002	94.7	1.10	94	116	1.08	12.9	222	365		415	TRUE
	Wolf	2003	139	1.24	138	211	0.95	31.6	359	365	Beaver activity affects record	415	TRUE
16	Spanish	2002	638	42.6	595	2194 OR[1]	37.8	155	217	227	Installed November 2001, some data lost due to battery failure.	302	FALSE
	Spanish	2003	525	11.8	513	768	11.3	167	335	365	Beaver activity affects record	302	FALSE

[1]OR =

For peak flows that are "over the rating", the discharge is calculated based on extrapolation of the existing rating table. No measurements are available that define the stage flow relationship during the peak flow event. Therefore, there is no estimate of the relative accuracy of these values.

CHAPTER III

DISCUSSION OF INDIVIDUAL MONITORING SITES

Figure 9. Goodrich Creek

Goodrich Creek was discontinued as a Monitoring Reach in 2001, due to further access denied by the owners. Geomorphic parameters showed a general improving trend from 1999 to 2001. Temperatures in Goodrich Creek were only measured in 2001, the worst water year. However, the max temp only reached 73F, and the max 7-day average was 69F. Temperatures were moderately conducive for trout production. We were never able to electroshock the reach. Nutrients were comparable to other sites, however, this site had the 2nd highest fecal coliform on 2001. This was one of the two sites that showed a clear decline from '99 to '01 in all five macroinvertebrate metrics displayed in Table 12.

Figure 10. Butt Creek

The geomorphic indicators showed an ambiguous mix of static, improving and declining trends. The channel slope appears to be increasing, but it is not known if that increase is actual or due to survey error. The crew leader stated that the site appeared the same each year of the survey. Water temperatures in Butt Cr are conducive to trout production, and this was reflected in the fish surveys, with the highest salmonid production of any site. Butt Cr was also the only site with riffle sculpin. However, several large suckers were present in the 2003 survey, while there were no suckers at all in the 2001 survey. Butt Cr didn't stand out in water quality except with the 4th highest Cr, and surprisingly, the 2nd highest total, and 6th highest fecal, coliform in 2001. Then in 2003, it had the lowest total coliform, and 7th highest fecal.

Figure 11. North Fork Feather River above Lake Almanor (@ Domingo Springs)

This site is not an alluvial site, and as with most of the non-alluvial sites, geomorphic characters remained primarily the same from 1999 through 2003. (Bankfull elevation of cross-section 1 appears to have been erroneously identified in 2003.) Banks seem to be steepening in cross-section 3, and the profile appears to be slightly steepening. Water temperatures appear to be very conducive to trout production. However, due to the volume of water at this site, no electroshocking surveys have been conducted. The site appeared to have slightly elevated phosphates, and the sixth highest fecal coliform in 2003. This was the other of two sites that showed a clear decline from 1999 to 2001 in all five macroinvertebrate metrics.

Figure 12. North Fork Feather River above the East Branch (@ Gansner Bar)

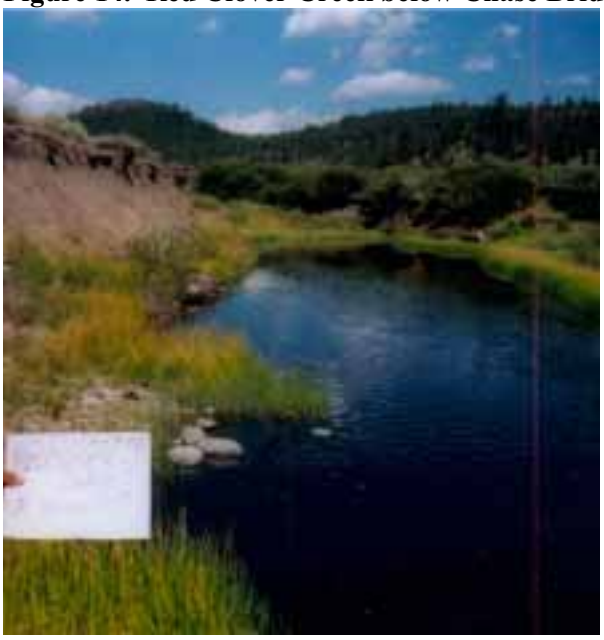
Total Watershed Acreage: 704,000
This site is not alluvial either, and is highly regulated, being downstream of Lake Almanor, Butt Valley dam, and Caribou Reservoir. Here again, most geomorphic parameters were static, with a couple of ambiguous changes. The reach was shortened in 2001 due for safety. Water temperatures are conducive for trout, but the reach has not been electroshocked because of too much water. The site had relatively good water quality, with some of the lowest fecal coliform counts, and mostly static macroinvertebrate metrics.

Last Chance Creek at Doyle Crossing
(No photo) This is a Continuous Recording Station. As with the downstream Monitoring Reach site, temperatures at this site are too warm for trout production.

Figure 13. Last Chance Creek (below Murdock Crossing)

Watershed Acreage: (approx.) 81,790
This site showed an ambiguous mix of trends in geomorphic parameters, except for a steady improvement in entrenchment (i.e. its becoming less entrenched) and pool to riffle ratios. There was a slight, but steady decrease in residual pool depth, and a coarsening of substrate. Slope remained static. For water quality, Last Chance Creek is one of the warmest sites monitored, with a steadily increasing absolute max temperature. Some heavy metal concentrations, were notable, with the second highest Al & Mn; 3rd highest Zn, Hg, Fe and Cd; and 4th highest Cu and Pb. There were no other notable water quality parameters. No trout were detected in either year of fish surveys, although they have been known from this location historically.

Figure 14. Red Clover Creek below Chase Bridge



Red Clover Creek has had several sites monitored. SCI was completed by the Forest Service in 1995 below the Chase Bridge (there was a later survey they did above the bridge, and another 1995 Forest Service survey at Notson Bridge). The FRCRM crew was able to locate the cross-section markers from 1995, and repeated the survey in 2003 (a profile was done here as well in 2001). The CRM decided to add this site to its SCI surveys because of the pending work to be completed just upstream on private land, and because the Drum Bridge site is not alluvial. (The FS is also planning restoration work at this site.) The slope stayed the same between 2001 and 2003. Substrate showed some coarsening, and the channel was slightly more entrenched. Because of the recent addition of this site to the CRM surveys, there were no water quality samples taken. A Hobo temperature logger was lost in 2003, presumably due to beaver. The fish survey in 2003 captured one rainbow trout as well as suckers and dace.

Figure 15. Red Clover Creek at Notson Bridge

Watershed Acreage: 69,190

This is a continuous recording station site, here looking downstream from the bridge. Temperatures appear to be slightly increasing at this site from 2000 to 2003.

Figure 16. Red Clover Creek abv Indian (blw Drum Bridge)

Watershed Acreage: 77,866

As mentioned above, this site is not alluvial. No geomorphic survey was conducted here in 2003. Between 1999 and 2001, all geomorphic parameters were basically static, except for a decrease in pooltail fines and the pool:riffle ratio. Temperature generally improved or was static from 2001 to 2003, as would be expected with the increased precipitation between those years, and was conducive to trout production both years. This section of Red Clover Creek is known as a good trout fishery, but no electroshocking survey has been done. Other water quality parameters were generally par with the other sites, although there was a slight increase in orthophosphate from 2001 to 2003.

Figure 17. Indian Creek abv Red Clover (DWR weir)

Watershed Acreage: (approx.) 71,300

This is a continuous recording station site. Temperatures generally followed the flow trend, and were generally good for trout production. Flows at this site, however, are affected by Antelope dam, which is approximately 10 miles upstream.

Figure 18. Indian Creek blw Red Clover (abv Flournoy Bridge)

Watershed Acreage: 279,804

This photo is of the downstream of the bridge, where Continuous Recording Station calibration measurements are made. The Monitoring Reach, above the bridge, was originally to be placed above Red Clover Creek, although in this location, it does help put flow and precipitation data at Taylorsville in context of upper vs. mid-watershed sources. The geomorphic parameters were basically the same between years, except maximum bank full depth seems to be increasing, and the upper pools deepening. The temperature trend was unexpected because 2003 was similar to 2001, despite the increase in flows and cooler air temperatures. This site was also generally warmer than the DWR weir site. There was fairly good water quality at this site, except in bacteria, which showed the 4th highest total coliform in 2001, and fecal coliform in 2003. This site was also one of the top 8 total coliform sites in 2003. There was much higher fish productivity in 2003 than 2001, which may have been due to the water year, or, perhaps the microhabitats sampled.

Figure 19. Indian Creek blw Taylorsville Bridge

Watershed Acreage: 343,289
This site is both a Monitoring Reach and a Continuous Recording Station. Geomorphic parameters were basically the same at this site as well, with a slight coarsening of substrate. Unfortunately, the temperature sensor was out of the water at this site in the summer. There were no notable water quality parameters. There were more salmonids captured in 2003 than 2001, probably due to flows. This site was also monitored for storm turbidity in 2001 and 2002 under Prop 204 funding. In the 2001 sampling period, there were an estimated 114 tons of suspended sediment that moved through this site.

Figure 20. Lights Creek (abv Deadfall Bridge)

Watershed Acreage: 67,721
This site is both a continuous recording station and a Monitoring Reach. As mentioned above, despite increasing precipitation from 2001 to 2003, Lights Creek has shown a steady decline in the 7-day average minimum flow. Geomorphic parameters showed an ambiguous mixture of trends, although a slight but steady decrease in BF depth and entrenchment. Cross-sections 1 and 3 also showed a steady decrease in cross-sectional area, all of which could either point to an improving trend or increased sediment supply from upstream sources. Absolute max temperature and the 7-day max rose steadily from 1999 to 2003. Other temperature metrics followed the flow pattern, as expected. This site also had one of the 3 highest ammonia readings in 2001, and moderately elevated total phosphorus (P), and ortho-phosphate. Lights Creek also ranked fairly high in metals, with the highest concentrations of Cu, Ag, and Mn; second highest Al, Cd, Fe and Zn; third highest Cr; 4th highest As and Se; and 5th in Ni; and 7th in Hg. The total coliform test covered the plate in 2001, and had the 5th highest fecal count. In '03 the site was in the top 8 in total coliform, and top 2 in fecal. In the two years of electroshock sampling, no salmonids were captured, as would be expected considering the high temperatures. This, also, was the only site with bullheads present in 2003. This site was also monitored for storm turbidity in 2001 and 2002 under Prop 204 funding. In the 2001 sampling period, there were an estimated 60 tons of suspended sediment that moved through this site.

Figure 21. Wolf Creek

There are two monitoring sites on Wolf Creek; a Continuous Recording Station on the Main St Bridge in Greenville, and a Monitoring Reach about one mile downstream near the town park. Both sites are entrenched. This is the most urban of all of the monitoring sites, and was also the site of an intensive three-phase CRM restoration project in the early 90's. Trends in geomorphic parameters were mostly ambiguous. However, pebble counts showed an improving trend, and cross-section 2 appears to be deepening. The increase in pool numbers is probably due more to a change in pool definition than a change in the reach. Temperatures increased slightly from the upper site to the lower site in 2001, the only year with data from both sites. Both sites were marginal for trout production, and in fact, no trout were captured in '01 or '03. There does not appear to be a nutrient problem, and there was a decrease in both phosphorus concentrations from '01 to '03. Although, Wolf Cr had the highest Hg concentration of any site (and the 5th highest As). Coliform changed for the worse between years, with low total in '01, and 8th highest in fecal; moving up to one of the top 8 in total coliform in '03, and one of the top two in fecal. This site was also monitored for storm turbidity, with results in the 204 report. This site was also monitored for storm turbidity in 2001 and 2002 under Prop 204 funding. In the 2001 sampling period, there were an estimated five tons of suspended sediment that moved through this site.

Figure 22. Indian Creek abv Spanish Creek (@ Dawn Institute)

Watershed Acreage: (approx) 478,590

This site is at the mouth of Indian Creek. It is not located at the mouth of Indian Valley, however, and water travels through an eight-mile canyon before reaching this site. Geomorphic parameters were basically static or ambiguous in this non-alluvial reach. Pebble counts showed a coarsening of material from 2001 to 2003. This site had the highest total dissolved solids, with high electroconductivity and alkalinity as well. Phosphorus was detected, but was not in as high concentration as some other sites. Metals were somewhat high, with the 2nd highest As concentration; the 3rd highest concentrations of Cu, Mn & Se. Coliform was relatively low (except 9th highest total coliform in '03). This site was not electroshocked due to the volume of water.

Figure 23. Rock Creek (Spanish Trib)

Watershed Acreage: 24,416
Major land use: timbered National Forest land
Geomorphic parameters were basically static. This site is actively mined, and the increase in residual pool depth may have been due to mining (as could be the increased max bankfull depth at cross-section 3 and coarsened pebble counts). This creek has good water temperatures for trout production, which was corroborated in the electroshock surveys both years. As expected, both temperature and macros followed the flow trend. Rock Creek was also low in nutrients, and the only metal of note was the 2nd highest concentration of Ni. In both '01 and '03 this site was one of the highest in total coliform, but one of the lowest in fecal coliform.

Figure 24. Spanish Creek at Hwy 70 (Gansner Park)

Watershed Acreage: (approx) 55,500
This is Continuous Recording Station site. This recorder is also equipped with a turbidity meter. And, as expected, the turbidity follows the flow. However, there was some low flow turbidity due to construction just upstream of the sensor. Flows at this site may be skewed due to a beaver dam downstream of the sensor, but as with any site with beaver activity, the final flow data are calibrated to negate that effect, to the fullest extent possible. This site shows slight temperature impairment. In summer 2003 a Hobotemp recorder was placed upstream above Rock Creek. Those data have not yet been summarized. That information may be helpful in the Spanish Creek Assessment, which began in December 2003. The assessment is expected to lead to channel stabilization projects.

Figure 25. Greenhorn Creek abv Spanish Creek

Watershed Acreage: 44,695
The site is located at the mouth of Greenhorn Creek, after it travels through American Valley. Geomorphic changes at this site include a barely perceptible increase in average bankfull width, and corresponding increasing width to depth ratio. Entrenchment, however, is remaining steady. The pool to riffle ratio and residual pool depth is also steadily increasing, and substrate particles decreasing in size, all of which point to some changes taking place that warrant continued monitoring. The slope was the same from 2001 to 2003, and perhaps the change from 1999 is due to a survey error (this is the first site that is surveyed each year). There was a general improvement in temperatures (i.e. cooling) from 2001 to 2003, as expected with the increased flows. Greenhorn temperatures are marginally good for trout, and this site was low in nutrients. No metal concentrations were particularly noteworthy. Bacteria could be a concern, with this site tied with the neighboring Spanish abv Greenhorn site for the 3rd highest concentration of fecal coliform in 2003. Random turbidity monitoring showed an expected increase in turbidity from just above American Valley to this site at the mouth. Fish productivity followed the flow trend, increasing in productivity from 2001 to 2003.

Figure 26. Spanish abv Greenhorn

Watershed Acreage: 61,041
This site is adjacent to the Greenhorn abv Spanish site, also at the mouth of American Valley. Geomorphic parameters were basically static, but showed a slight increase in width, depth and entrenchment, a slight decrease in pool-tail fines, and a coarsening of the bedload. Temperatures were marginally good for trout in ’01. Nutrients could be a concern with the 2nd highest nitrate/nitrite concentrations of any site. This site also had the highest Ni concentration. As mentioned above, this site had high fecal coliform in ’03, but had low total coliform in both years. Random turbidity monitoring showed a steady increase in turbidity from above American Valley to this site. This site was also consistently more turbid than the neighboring mouth of Greenhorn Creek. The 2003 fish sampling effort captured more trout than in 2001, but there was a shift toward brown trout.

Figure 27. Spanish Creek abv Indian Creek

Watershed Acreage: 129,305

This site is characterized as depositional, but not really alluvial, as it is in a canyon. Geomorphic metrics were mostly static or ambiguous, although the slope increased and pools deepened slightly. Temperatures are marginally good for trout production. In 2001 temperatures increased slightly from abv Greenhorn Creek to here. Neither nutrients nor metals appear to be problematic here. This site was also about median for coliform both years, but was in top 8 for total in '03. There were no electroshock fish surveys at this site, due to the volume of water. Also, of note is that during casual observances from the junction of highways 70 and 89, where Spanish and Indian Creeks join to form the East Branch North Fork Feather, Spanish Creek is almost always less turbid than Indian during high run-off or storm events.

Figure 28. East Branch North Fork Feather River abv North Fork Feather

Watershed Acreage: 661,880

This site is not alluvial, and most geomorphic parameters were static, with a trend toward more fines in the substrate. Maximum bankfull depth also slightly increased. Temperatures here were very marginal for trout, and were generally warmer than Spanish or Indian Creeks, but Indian Creek appears to be the source of slightly warmer water. This site also had some of the highest EC and TDS readings, and was highest in As concentration (4^{th} in Ni, and 5^{th} in Cu). It also seems to have no nutrient problems, and was relatively low in coliform. No fish surveys were conducted here due to volume of water.

Figure 29. Middle Fork Feather River at Beckwourth

Geomorphic parameters were mostly ambiguous at this site. However, some trends did show that pebbles coarsened, and that the channel is imperceptibly increasing in entrenchment, with a deepening average bankfull depth, and max bankfull depth increasing at cross-sections 1 and 3, all of which could indicate a declining trend, and at least warrant further monitoring. Slope is only graphed from the 1999 survey, because water surface elevations were not available due to a dry channel in 2001 and 2003. When there is water in the channel, it is marginal for trout. Presumably because of the low flow, this site had the worst overall water quality. It had the highest TDS and EC, and was five times higher in phosphorus than the next highest site. It also had the highest ammonia, and second highest nitrate/nitrite. It had the highest concentration of Al, Cd, Cr, Fe, Pb and Zn; 2nd highest Se and Cu; 3rd highest As; and 4th highest Hg and Mn. It was not sampled in September '03, but had the highest fecal coliform in '01. Again, due to lack of continuous surface water, there has not been a fish survey at this site, and macros were only collected in '99.

Figure 30. Sulphur Creek at Clio

Watershed Acreage: 25,300

This site is just above the mouth of Sulphur before it drains into the Middle Fork Feather River. A continuously recording station is scheduled to be installed here in early 2004. There is a Forest Service SCI site further upstream in this watershed above Mohawk Valley. Data from these two sites will be compared and incorporated into the Sulphur Creek Watershed Assessment. Most geomorphic parameters were static at this site, with the exception of barely perceptible decreasing entrenchment, coarsening of substrate, and an increase in max BF depth at xsecs 2 and 3. There appears to be a slight warming trend in temperature from '01 to '03, which should be more closely monitored, since flows increased, and one would expect temperatures to improve. Temperatures in both years were fairly conducive to trout production. This site was a close second to the MFFR at Beckwourth in high nutrient concentrations; it also had the 3rd highest fecal coliform in '01, and 2nd highest in '03. Turbidity at three sites along the mainstem and at two tributaries is being randomly monitored by volunteers as part of the citizen monitoring portion of the Watershed Assessment. This site had the highest Se. There were salmonids captured in both '01 and '03, with an increase in productivity in '03. This site also had the highest fish species diversity of any site in '03 (perhaps because its so close to the Middle Fork).

Figure 31. Jamison Creek

This watershed has had extensive historic mining, which left a legacy of an unstable channel within Plumas-Eureka State Park. The site is non-alluvial, and was basically static in all geomorphic parameters. As expected, temperatures improved from ’01 to ’03, and were conducive to trout both years. Nutrients and coliform were also not an issue at this site. The site had the 2nd highest Hg of any site. The only fish survey was conducted in ’01, when only rainbow trout were captured. Opposing the declining flow trend from ’99 to ’01, this was the one site where macroinvertebrate metrics showed an improving trend.

Figure 32. Middle Fork Feather River abv Nelson Creek

This is a federally designated Wild and Scenic River and California Wild Trout Fishery. There was basically no change in geomorphic parameters at this non-alluvial site, except for a steady decrease in percent fines, and a fining of the substrate. Temperatures in ’01 were marginal for trout production. Nutrients and bacteria were low in all categories, except for a surprising 3rd highest concentration of total phosphorus in ’01, and inclusion in the top 8 highest total coliform in ’03. The only noteworthy metals result here is the 5th highest concentration of Hg. Fish were not surveyed at this site due to high volume of water.

CHAPTER IV

RECOMMENDATIONS FOR FUTURE MONITORING

General

As mentioned previously, the data above provide a good picture of baseline conditions to which future conditions can be compared. The collection of these data was somewhat intensive. This section attempts to recommend future monitoring efforts with the assumption of declining resources, and with the realization that it is the simplest and least expensive monitoring that is most likely to continue into the future for the long term. The FR-CRM's watershed monitoring program is an iterative process. It should be noted that the following are preliminary recommendations by CRM staff, and need to be evaluated further by the TAC. Table 14 at the end of this discussion suggests monitoring schedule.

- Geomorphic monitoring was designed for alluvial channels in relatively small (less than 10,000 acres) watersheds. While the TAC wanted to collect full baseline data at non-alluvial sites, these sites are the lowest priority for continued geomorphic monitoring, and would probably only be re-surveyed after a major event. GIS'ed permanent stakes will allow future geomorphic monitoring when further surveys are warranted.
- The best schedule for further geomorphic monitoring at alluvial sites would be event-driven (i.e. significant bedload movement). However, due to funding realities, if that is not possible, these sites should be re-surveyed on a five-year basis (or perhaps ten-year for bed-load samples).
- Water Quality – Sediment and temperature are the two highest water quality concerns in the upper Feather. Temperature is currently being continuously monitored at 8 stations throughout the watershed. Summer temperature data can be easily and inexpensively monitored at many sites of interest with Hobotemp loggers, and could continue on an annual or biennial basis. Sediment monitoring is more complicated than temperature. Currently, continuous recording turbidity meters are installed in Spanish at Hwy 70 (Gansner Park) and Indian at Taylorsville. Volunteers in Sulphur Creek and American Valley are randomly monitoring turbidity. To get a clear picture of sediment, however, depth integrated samples should be taken during storm events. This effort cost about $12,000 a year in Indian Valley alone, during relatively uneventful years. At this time, the TAC was not enthusiastic about investing limited resources in sediment monitoring, and felt that other parameters can show changes in the watershed.
- Flow- Flow is monitored at the Continuous Recording Stations. Especially when compared to precipitation data, flows can say a lot about watershed condition. These sites should continue to be maintained and calibrated.
- Biota- Fish population surveys should continue every five years. Macroinvertebrates should also be continued every five years, and be used as a screen for further water quality testing.

Goodrich Creek

This site is discontinued because of access denied by the landowner. If access is allowed once again, full geomorphic monitoring should continue here, as it is a good example of an alluvial system high in the North Fork Feather watershed.

Butt Creek

Lassen National Forest also has a Monitoring Reach site on Butt Creek. Before further monitoring, these sites need to be compared, and a determination made as to whether or not both sites should continue, or one eliminated.

North Fork Feather River above Lake Almanor (@ Domingo Springs)

Because this site is not alluvial, the need for another geomorphic survey should be evaluated only after a large flow event. Because of somewhat marginal baseline data results, it should continue to be monitored for water quality and macroinvertebrates.

North Fork Feather River above the East Branch (@ Gansner Bar)
Because this site is not alluvial, is highly regulated, and had relatively good baseline water quality data, it is low priority for further surveying of any type, unless warranted by other observations. Also, prior to future surveying, PG&E needs to be contacted to see if they have pertinent data. The primary utility of this site may be for an academic comparison of this sediment-starved system to the unregulated East Branch site.

Last Chance Creek (below Murdock Crossing)
Watershed Acreage: (approx.) 81,790
The Plumas National Forest also has a site on Last Chance Creek, relatively close to the CRM site. Before further monitoring at this site, the data between these sites needs to be compared, and perhaps, one site eliminated. (Or perhaps not, as the comparison could show how much site-specific noise there is in the data.) One of the sites, however, should be a high priority for further intensive monitoring. There is a Continuous Recording Station upstream at Doyle Crossing, and this watershed is a high priority for restoration. Data at this site are expected to show changes due to management and restoration changes. This is a high priority site.

Red Clover Creek below Chase Bridge
Red Clover Creek is another site with high priority for further intensive monitoring, as management changes and major restoration are planned upstream, as well as on-site by the Forest Service. See Last Chance, and apply here as well.

Red Clover Creek at Notson Bridge
The Continuous Recording Station at this site should be maintained, calibrated, and upgraded with dial-up or satellite remote data retrieval capabilities.

Red Clover Creek abv Indian (blw Drum Bridge)
This site is not alluvial, and should only be re-surveyed for geomorphic parameters when other observations warrant. Nutrients and temperature may be monitored more frequently, or monitored at Chase or Notson bridges.

Indian Creek abv Red Clover (DWR weir)
Since this site is already equipped with a Continuous Recording Station, it should continue to be monitored, (although flows at this site are highly affected by operations at Antelope Dam).

Indian Creek blw Red Clover (abv Flournoy Bridge)
Even though this site is alluvial, it is relatively lower priority for all monitoring because it is below Red Clover Creek. Although this site is upstream Grizzly Creek and other tributaries, as well as the millrace diversion above the Taylorsville Bridge. The Continuous Recording Station on Flournoy Bridge needs to be checked for accuracy.

Indian Creek blw Taylorsville Bridge
This site remains interesting for monitoring because it is at the beginning of Indian Valley, and is below the millrace diversion. Both Continuous Recording Data (including turbidity) and Monitoring Reach data are collected here. This site is a relatively high priority for monitoring.

Lights Creek (abv Deadfall Bridge)
This site is both a continuous recording station and a Monitoring Reach, and is relatively high priority for further intensive monitoring because of the marginal baseline data results, and because it is an important tributary to Indian Creek.

Wolf Creek
Same as Lights Creek.

Indian Creek abv Spanish Creek (@ Dawn Institute)
Indian Creek is a large and important creek in the Upper Feather, with major degraded valleys, and on-going restoration work. Much thought was given to the placement of this site at the mouth of Indian Creek. It is not an alluvial site, however, so geomorphic measures should only be taken after a large event. Water quality measured here is improved as it moves through the canyon after it leaves Indian Valley. The TAC needs to re-evaluate this site for its efficacy in answering questions about the Indian Creek watershed. Or, perhaps, to stay comparable to Spanish Creek data, a water quality station should be added to Indian Creek closer to the end of the valley (although, the TAC was not able to locate a good geomorphic station near the end of the valley).

Rock Creek (Spanish Trib)
This site is not alluvial, however it is at the base of an important tributary to upper Spanish Creek. The site is also actively mined, which presumably affects the geomorphic data. However, because of the intensive study and restoration work requested by landowners in American Valley, this site should remain a relatively high priority site for continued intensive monitoring.

Spanish Creek at Gansner Park
This is another Continuous Recording Station without a Monitoring Reach. Because of the assessment project, as well as the downstream Monitoring Reach, this recorder should be maintained and calibrated.

Greenhorn Creek abv Spanish Creek
The site is located at the mouth of Greenhorn Creek, after it travels through American Valley. It is an excellent site for monitoring water quality leaving American Valley, and geomorphic changes in response to changes in Spanish Creek. It is a high priority site for continued intensive monitoring. Water quality monitoring, however, could concentrate on bacteria levels and nutrients rather than metals.

Spanish abv Greenhorn
Same as Greenhorn above Spanish.

Spanish Creek abv Indian Creek
Similar to the Indian above Spanish site, this is non-alluvial, and perhaps needs to be re-evaluated for the efficacy of geomorphic measures. However, this site may continue to be interesting for temperature and water quality, as it is at the mouth of Spanish, and gives the final picture of Spanish Creek water before it mixes with Indian Creek, and after it has had a chance to run through about eight miles of canyon after leaving American Valley.

East Branch North Fork Feather River abv North Fork Feather
This site is not alluvial and is low priority for intensive monitoring. Further geomorphic monitoring would be conducted after a large event. Temperatures could continue to be monitored.

Middle Fork Feather River at Beckwourth
This site should continue to be monitored due to evidence in the baseline data of problems with channel stability, water quality, and flow. This site is also at the mouth of Sierra Valley, which may be seeing increased restoration efforts.

Sulphur Creek at Clio
This site is just above the mouth of Sulphur before it drains into the Middle Fork, and continues to be a high priority for intensive monitoring, as the Sulphur Creek Watershed Assessment is near completion, and restoration projects get underway.

Jamison Creek

This non-alluvial site should be sampled again only after a large flow event, as this channel has relatively large substrate, and seems to move only after large events.

Middle Fork Feather River abv Nelson Creek

This is a federally designated Wild and Scenic River and California Wild Trout Fishery. Because it is non-alluvial, this is another low priority site for further monitoring until after a high flow event.

Recommendations for Data Management

In the short-term, re-organize data from site-specific Excel spreadsheets to a database-like format in Excel. Continue to include spatial data in any monitoring work. Long-term data management may include conversion to an actual database, if resources become available. Current constraints to database conversion are the personnel skills that can manage this type of data management.

Recommendations for Field Surveys

- Take old profile and cross-section graphs to the field for reference in future cross-section and profile surveys. An attempt should be made to repeat the same elevations and features during each survey. This will aid in year to year comparison of the data.
- In surveying, closer attention needs to be paid to make sure the rod is exactly at the water surface elevation.
- Take the USDA-FS GTR RM-245 (Harrelson, et al. 1994) to the field to assist in bankfull determinations.
- Enter permanent (and perhaps transect cross-sections?) into the XSPRO program to determine bankfull cross-sectional area. Drive in a rebar stake at the next surveyed bankfull elevation to help determine bankfull in future surveys.
- For electrofishing, the Monitoring Reach files should be reviewed so that habitat types, locations and fishing effort can be repeated. Spanish Cr above Greenhorn should be re-evaluated as a sampling site, because of the presumably heavy fishing pressure at this site.

Recommendations for Flow Measurements

Continue to maintain and refine this data collection effort. Continuously recorded temperature and flow data are perhaps the most informative and least expensive of the watershed monitoring efforts. Continue to refine rating tables for each of the sites with flow measurements at needed stages. Annually calibrate temperature probes according to manufacturer's suggestions. Re-position the Taylorsville probe to accommodate both high and low flows. Examine Wolf Cr and Flournoy Bridge sites for malfunction, as the 2003 data seem anomalous. Determine what should be done with beaver dams downstream of sites. Continue to collect several more years of data to develop a 7-station average.

See Table 14 for a suggested monitoring schedule.

Table14. Suggested Monitoring Schedule (all stations are Monitoring Reaches unless otherwise noted)

Existing Station	**Annual or Biennial**	**Pri-ority**	**5 years or moderate event**	**Pri-ority**	**10 Years or major event**	**Pri-ority**
Goodrich			Geomorph, WQ, Temp, Biota	M		
Butt*			Geomorph, WQ, Temp, Biota	M		
NFFR abv Almanor			WQ, Biota	M	Geomorph	M
NFFR abv EBNFFR					Geomorph, WQ	L
Last Chance*	temperature	H	Geomorph, WQ, Temp, Biota	H	Same as 5 yr	H
RedClover@ Chase	temperature	H	Geomorph, WQ, Temp, Biota	H	Same as 5 yr	H
RedClover blwDrum	temperature	M	WQ, Temp	M	Geomorph, WQ, Temp, Biota	M
Indian blw Red Clover	Continuous recorder here	N/A	Geomorph, WQ, Temp, Biota	ML	Same as 5 yr	ML
Indian blw TvilleBridge	Continuous recorder here	N/A	Geomorph, WQ, Temp, Biota	MH	Same as 5 yr	MH
Lights	Continuous recorder here	N/A	Geomorph, WQ, Temp, Biota	MH	Same as 5 yr	MH
Wolf	Continuous recorder here	N/A	Geomorph, WQ, Temp, Biota	MH	Same as 5 yr	MH
Indian abv Spanish*			WQ, Temp	M	Geomorph, WQ, Temp, Biota	M
Additional Station- Indian blw Indian Valley	WQ, temp	M				
Rock			Geomorph, WQ, Temp, Biota	MH	Same as 5 yr	MH
Greenhorn abvSpanish	temperature	H	Geomorph, WQ, Temp, Biota	H	Same as 5 yr	H
Spanish abv Greenhorn	temperature	H	Geomorph, WQ, Temp, Biota	H	Same as 5 yr	H
Spanish abv Indian*			WQ, Temp	M	Geomorph, WQ, Temp, Biota	M
EBNFFR			Temp	M	Geomorph, WQ, Temp, Biota	L
MFFR@ Beckwourth	temperature	H	Geomorph, WQ, Temp, Biota	H	Same as 5 yr	H
Sulphur	temperature	H	Geomorph, WQ, Temp, Biota	H	Same as 5 yr	H
Jamison					Geomorph, WQ, Temp, Biota	M
MFFR abv Nelson					Geomorph, WQ, Temp, Biota	M

*More information is needed before the next monitoring effort (see discussion above).

REFERENCES

"Stream Condition Inventory Guidebook" version 4.0, United Stated Department of Agriculture, Forest Service, Pacific Southwest Region, 1998.

“Feather River Coordinated Resource Management Monitoring Plan- 319(h) Program”, 1997.

XSPRO: A channel cross-section analyzer. Grant, G. et al. 1992. USDA Forest Service & USDI Bureau of Land Management. Technical Note 387.